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Castings Carry Messages with Speed and Accuracy

IMPROVEMENTS constantly are being made in methods of communication. One of the recent developments, the telegraphing typewriter, offers a rapid means of sending messages between two or more points. The machine is a distantly controlled typewriter and is the result of many years of study by the foremost engineers engaged in telephone and telegraph work. The machines, which operate similar to a typewriter with a speed of around 65 words a minute, are connected by a wiring system. A depression of a key on the sending machine causes the corresponding character to be printed on that machine and at the same time the letter is reproduced on one or more machines connected to the sending unit. Any machine may be used either as a sending or a receiving unit. The machine is made in two models, one which typewrites the message on a narrow ribbon of paper and the other which typewrites its message on a standard 8½-inch sheet of paper. The machine is built almost entirely of metal. It has a cast iron base and numerous die castings are used in its construction. A duplicating machine, made up chiefly of gray iron castings may be used in connection with the telegraph machine for making additional copies of messages received.

The Telegraphing Machine Is Replacing the Telegraphing Instrument as a Means of Sending Messages

Find Where Castings May Be Sold

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Brass Is Cast Successfully in

Southern Car Foundry Produces Bearing and Bushing Metals in Chill Molds

PERMANENT molds or chill molds as they commonly are known, have been in use for some years past in certain foundries specializing in the production of copper base bearing and bushing metals for locomotives. They are suited ideally for the casting of lead bronze castings of heavy section in which the amount of this white metal is not over 30 per cent and the tin not less than 4 per cent. For by their chilling effect on the molten mass causing rapid solidification, they help admirably the holding power of tin in regard to lead so that lead sweating and segregations are prevented. The resulting alloy has a fracture of an exceedingly fine, homogeneous microstructure in which the solid solutions of copper-tin as well as copper and lead are distributed evenly throughout the casting.

Fig. 1 (Left)—Pouring a Phosphor - Bronze Bushing with a Teapot Spout Ladle

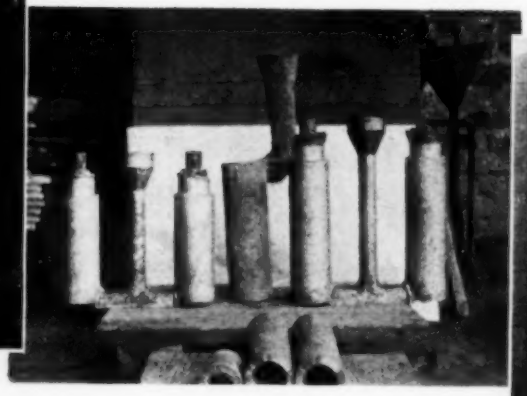


Fig. 2 (Above)—Permanent Mold Castings with Sand Casting in Center. Fig. 3 (Right)—View of Furnace Burner Arrangement

Permanent molds can be exploited to good advantage, though less successfully than in the case with lead bronzes, in the manufacture of binary copper-lead bearing alloys in which the lead may be as high as 40 per cent. Unfortunately, as it is in the case when such alloys are cast in sand, though in a less pronounced way, they are deficient in tensile and compressive strength, toughness, and resilience, and acquire a characteristic brittleness accompanied by a profusion of lead sweating at temperatures little above 300 degrees Fahr. so that they cannot be subjected to heavy loads, shocks or vibration. Even with their wonderful anti-frictional qualities their field of usefulness is rather limited.

It also is apparent to us as result of our experience in casting lead bronzes of low tin and binary alloys of copper-lead in permanent molds at the Lenoir Car Works, Lenoir City, Tenn., that the chilling effect of the iron mold on these last mentioned alloys is not rapid enough for heavy section castings to destroy the conjugate liquid phases of copper and lead at solidification referred to by Owen W. Ellis, Guertler and Mensel, and Paravano and Manzetti. Consequently, lead sweating and segregations of copper and lead in those binary alloys containing 35 per cent lead and above are almost as common with permanent mold-cast alloys, though of lesser intensity, as they are with sand mold cast. However, by reason of the permanent mold chilling effect referred to previously, worthwhile improvements can be imparted to the micro-

in Permanent Molds

By Henri Marius

structure of these copper-lead alloys, with small additions of tin (2 to 5 per cent depending on the amount of lead).

In red brass proper or in more or less true bronzes for steam fittings and castings that are subjected to superheated steam, high hydraulic pressures or hard wear and in which lead becomes a rather objectionable constituent, seldom being contained in such alloys in greater amounts than 3 per cent, the permanent mold still holds marked usefulness. This method is being adopted rapidly in the manufacturing of various kinds of nonferrous and for that matter ferrous alloys of design adaptable to that type of molding.

After due deductions for certain unfounded accomplishments attributed to these mechanical molds by well meaning but misinformed optimists, the fact remains that whatever the composition of brass or bronze when cast in permanent molds, it possesses the following important advantages over the same sand cast alloys:

Greater machinability due to finer, more homogeneous microstructure of even hardness and to complete absence of burned-in sand on the skin of the casting and for the same reasons; greater strength as expressed by uniformly higher elastic limit, tensile and compressive strengths with good toughness and ductility. This is shown clearly by the figures in Table I.

In regard to hardness, the uninitiated may get the impression that the chilling in permanent molds must harden and embrittle brass in a similar manner as does chilling of gray iron or high carbon steel. Such is not the case. Brass and bronze castings made in permanent molds, aside from their characteristic crispness inherent to this mode of molding and which enhances machinability by keeping the cutting tool *ungummed* show little increase in hardness over sand mold castings of same composition as shown in Table II. Part of this small increase in hardness is rather the natural result of finer microstructure and a corollary expression of greater all around strength of permanent mold cast alloy, and since it is not accompanied by any undue brittleness, it is rather beneficial than detrimental.

Fig. 6—Pouring Operation Just Before Mold Is Filled

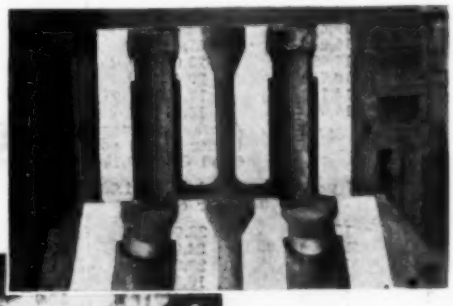


Fig. 4 (Left)—Molds Remain Permanently in Place. Fig. 5 (Above)— Cores Are Held at the Top by a Holder and at the Bottom by a Recession in the Plate

Results of the physical tests contained in Tables I and II are representative of actual foundry practice over a period of four years. The data have been gathered together simply to express numerically so far as strength is concerned, the betterment in quality of brass and bronze through casting in permanent molds as compared with sand casting. All test bars were cut from actual castings, such as bearings, bushings, etc., and each permanent mold casting and sand casting from which the test bars were cut were identical in pattern, poured from the same heat, from the same ladle and the test bars were cut from the same position. This was done to have as

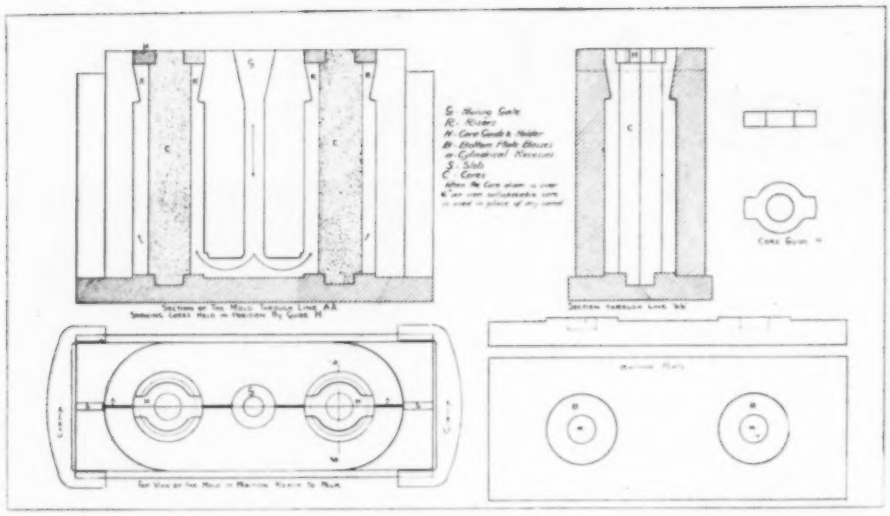


Fig. 7—Sketch Showing Component Parts of the Permanent Molds Employed

much as possible an accurate, true, representative, physical test of the castings rather than test bars which are not always truly representative of the castings. As it may be seen from the limits of variation of the chemical analyses and results of physical tests of the various bars no special attention or particular care was given to the test heats. They were picked at random and they represent good, bad and indifferent ones. In each case the furnace charge was composed of 98 per cent clean scrap and 2 per cent new metal.

Broadly speaking, hardness in brass and bronze, aside from that which is due to heavy oxidation from faulty melting, or from purposely inserted hardening metals such as iron, manganese, nickel etc., or from residual phosphorus when phosphor-copper is purposely or recklessly used as deoxidizer (in all these cases hardness is accompanied by marked brittleness), is a direct function of tin in both sand and permanent mold castings. The formation of binary solid solutions of copper-tin alloys corresponding most probably to the chemical formulas of $Cu_3Sn + Cu_2Sn$ or Cu_3Sn_2 and to a considerably lesser degree the eutectic Cu_2Sn_2 are the true agents of hardness, in brass and bronze.

At present we have no definite facts governing the quantitative formation nor the proportionate ratio of this system of copper-tin alloys but, it safely may be said that in sand cast brasses and bronzes all three compounds are present in greater or smaller quantities depending on the ratio of copper to tin, the amount of lead and zinc present, and the rate of solidification. Since $Cu_3Sn + Cu_2Sn$ or Cu_3Sn_2 is higher in copper than Cu_2Sn_2, the temperatures of its formation and solidification must be higher than that of Cu_2Sn_2. Such being the case, the question arises as to whether the eutectic Cu_2Sn_2 is present or absent in permanent mold cast brasses and bronzes, on account of the exceedingly rapid solidification coincident with this mode of molding.

Our investigation of this matter, though not complete at this time,

Table I

Comparison of Physical Properties

Heat Nos.	Dimensions of test bars	Thickness—Weight of castings test bars were cut inches	pounds	Pieces tested, average of	SAND CAST Elastic limit lbs. sq. in.	SAND CAST Ultimate tensile strength lb./sq. in.	SAND CAST Elongation 2 in. per cent	PERMANENT MOLD CAST Elastic limit lb./sq. in.	PERMANENT MOLD CAST Ultimate tensile strength lb./sq. in.	PERMANENT MOLD CAST Elongation 2 in., per cent
Cu 77.50 to 80 per cent—Sn 7 to 8 per cent—Pb 11.50 to 13.50 per cent—Zn 0.50 to 1 per cent—Sb 0.10 to 0.35 per cent—Undetermined—0.10 to 0.30 per cent										
40-26	0.505	1½	175	2	17,440	28,210	16.0	20,050	32,000	17.5
53-26	0.505	1½	120	3	17,930	30,300	17.0	20,000	35,000	20.0
68-27	0.505	2	200	3	16,410	28,100	16.0	20,500	33,650	19.0
102-27	0.505	2½	150	4	15,900	27,480	14.5	20,750	33,350	15.5
103-28	0.505	1	50	4	17,620	29,600	19.0	20,500	33,800	19.0
120-28	0.505	1	40	2	18,750	29,450	18.0	20,000	34,750	20.5
130-28	0.505	3	240	4	14,150	19,000	11.0	18,700	29,420	14.0
9-29	0.505	1¾	75	2	13,070	16,130	5.0	20,100	26,730	7.5
					Average permanent set in fraction of an inch Under 65,000 pounds load on one inch cubes Sand Cast—0.184 Permanent mold cast—0.162					
Cu 70 to 72 per cent—Pb 20 to 22.5 per cent—Sn 5 to 6 per cent—Zn 0.70 to 1.30 per cent—Sb 0.35 to 0.60 per cent—Undetermined 0.15 to 0.35 per cent										
32-26	0.505	2	200	4	15,000	23,040	9.0	18,500	25,150	11.0
70-26	0.505	1½	120	4	15,350	24,000	12.0	18,000	27,150	14.0
76-27	0.505	1½	175	3	16,670	23,250	7.0	17,600	26,750	8.4
4-28	0.505	3	240	4	14,400	18,600	6.0	18,700	27,800	13.0
6-28	0.505	2½	150	2	12,000	22,450	12.0	14,200	23,700	12.0
14-28	0.505	1	40	2	15,900	26,650	14.0	17,350	28,000	13.5
26-29	0.505	1¼	75	2	14,170	18,850	8.0	19,250	27,740	10.5
					Average permanent set in fraction of an inch under 65,000 pounds load on one inch cubes Sand Cast—0.240 Permanent Mold Cast—0.204					
Cu 85 to 87 per cent—Sn 6 to 7 per cent—Pb 3.5 to 5 per cent—Zn 2 to 3 per cent—Undetermined 0.0 to 0.2 per cent										
M20-26	0.505	1½	30	3	17,200	36,000	29.0	18,700	38,300	28.0
M48-26	0.505	1	15	2	20,050	34,900	24.0	21,300	37,000	20.0
M72-27	0.505	1	10	2	20,100	35,000	24.0	21,100	38,700	21.0
M77-27	0.505	2	120	4	18,300	35,500	32.0	20,000	40,150	32.0
M90-28	0.505	2½	100	4	17,940	29,760	23.0	19,380	34,000	21.0
M95-28	0.505	1¾	90	3	17,700	30,200	17.0	18,150	34,600	18.0
M104-28	0.505	1½	75	4	17,650	31,500	22.0	18,500	35,000	22.0
M109-28	0.505	2	50	3	15,000	25,400	14.0	17,800	29,430	18.0
M19-29	0.505	1¼	75	2	15,080	16,930	6.0	21,860	31,660	10.0
M21-29	0.505	1½	40	2	16,000	18,600	5.5	21,500	26,300	4.0

tends to show that in chill-mold brass and bronze castings of thin sections and containing no more than 7 per cent tin, the eutectic Cu_3Sn_2 is absent. All of the tin is in $Cu_3Sn + Cu_3Sn$ combinations. However, in heavy section castings and in which the tin is above 7 per cent, the eutectic is present, but in a much less amount than it is in the same castings when cast in sand. Now since the combinations of $Cu_3Sn + Cu_3Sn$ or Cu_3Sn_2 are harder than the eutectic Cu_3Sn_2, brasses and bronzes, when cast in chill molds will be somewhat harder than bronzes and brasses cast in sand but, as we have said already, this difference in hardness is not large enough to cause any marked advantage or disadvantage.

Show Uniform Hardness

While permanent molds have little effect on brass and bronze hardening, castings from such molds show a more uniform hardness throughout their mass than sand mold castings. This feature is quite evident in castings of heavy sections as shown in Table II. Due to slower solidification in sand molding, the tin forms Cu_3Sn_2 compounds at the core and Cu_3Sn_2 combinations at the walls. This condition is aggravated by the liquation of tin in castings of high tin content and in the presence of zinc and considerable lead.

Chill molds, aside from producing better quality brass and bronze, automatically eliminate all kinds of molding losses coincident with sand molding. Arguments between the metallurgist, foreman and molder, concerning suitability of this and that sand, proper tempering and preparation of same, the quality of facing materials, too hard or too soft ramming, scabbing, burning-in, porosity from steam from badly vented and wet molds, and so on, can be dropped out of the daily program. Furthermore, permanent molds of the right design reduce production costs materially.

Fig. 7 shows an extremely simple, duplex type permanent mold, made from special gray iron. It is particularly suited for casting red brass machinery bushings of thin walls, or solid, standard size, round sticks from which miscellaneous locomotive steam fittings are machined. It is the product of several years laboratory and foundry experiments and it embodies all such improvements which actual practice has taught us during that time. It possesses four important characteristics: Simplicity of design, sturdiness, ease of handling and low manufacturing cost. Several molds of this type are now in use at the Lenoir Car Works,

Table II

Hardness of Sand and Mold Cast Metal

Heat No.	Casting thickness, inches	Casting weight, pounds	Depth under skin, inches	Brinell hardness Sand cast	Brinell hardness Permanent mold
Cu 77.5 to 80%—Sn 7 to 8%—Pb 11.5 to 13.5%—Zn 0.50 to 1%—Sb 0.10 to 0.35%—Undetermined 0.10 to 0.30%					
40-26	1½	175	¼	62	66
			1	58	64
53-26	1½	120	¼	59	63
			1	55	62
68-27	2	200	¼	60	66
			1¼	54	65
102-27	2½	150	¼	58	61
			1¼	54	61
103-28	1	50	¼	61	67
			⅜	61	67
120-28	1	40	¼	65	69
			⅜	64	70
130-28	3	240	¼	62	64
			1½	50	64
9-29	1¾	75	¼	48	59
			1	44	59
Cu 70 to 72%—Pb 20 to 22.5%—Sn 5 to 6%—Zn 0.70 to 1.30%—Sb 0.35 to 0.60%—Undetermined 0.15 to 0.35%					
32-26	2	200	¼	57	60
			1	50	57
70-26	1½	120	¼	58	57
			⅜	53	57
76-27	1½	175	¼	58	60
			⅜	54	60
4-28	3	240	¼	54	61
			1½	47	60
6-28	2½	150	¼	54	59
			1¼	52	58
14-28	1	40	¼	53	59
			⅜	53	59
26-29	1¼	75	¼	50	60
			1	48	60
Cu 85 to 87%—Sn 6 to 7%—Pb 3.5 to 5%—Zn 2 to 3%—Undetermined 0.0 to 0.2%					
M20-26	1½	30	¼	60	62
			⅞	55	64
M48-26	1	15	¼	61	70
			⅝	65	67
M72-27	1	10	¼	61	61
			⅝	61	61
M77-27	2	120	¼	59	60
			1	57	60
M90-28	2½	100	¾	65	63
			1⅛	57	63
M95-28	1¾	90	¼	57	67
			1	55	66
M104-28	1½	75	¼	61	62
			1	57	62
M109-28	2	50	¼	55	65
			1	53	65
M19-29	1¼	75	¼	58	58
			⅞	51	57
M21-29	1½	40	¼	50	55
			1	48	55

Lenoir City, Tenn., foundries, where their records show that, in many instances, as many as five hundred brass bushings and sticks were poured in one mold without the mold showing any marked deterioration.

As it may be seen in Fig. 7, this duplex mold is composed of three main parts two side pieces forming the mold proper, with bottom pouring gage between. The molds end at the top in a conical shape forming the riser and this conical shape in turn ends in a cylindrical form in which fits concentrically the device *H* which encases and holds the core in the center of the mold. The side pieces rest or slide on a bottom plate and when in position they are held together by two steel clamps one on each end. The bottom plate has two bosses of same diameter as the bore of the molds which of course correspond to the outside diameter of the bushing to be cast. Each boss has a concentric cylindrical recess, and the bosses and recesses together act as guides to the molds and bushing cores, preventing them from shifting at the bottom. In the same manner the device *H* prevents the cores from shifting at the top. Naturally when the mold is used for pouring plain sticks a plain bottom plate is used.

Thickness of the mold walls are in direct proportion to the weight of the bushing the mold is supposed to cast, and it is determined from the following empirical formula derived from practical experiments:

$$\frac{W\,(t-t^1)}{Pr.Rt} \times \frac{l}{H} = T \text{ in which}$$

W = Weight of bushing
t = Pouring temperature of the alloy from which the bushing is made
t^1 = Temperature of the bushing at the shaking out
Pr = Time in minutes the bushing is desired to remain in the

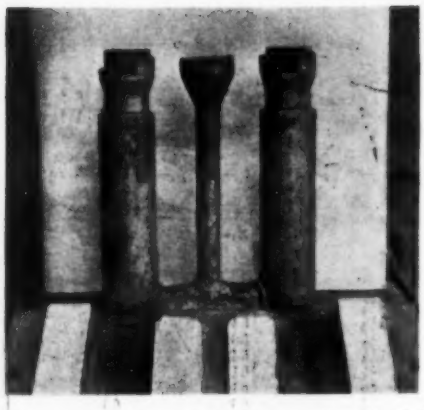


Fig. 8—Risers and Gates Crack Off Easily When Hot

mold before it reaches shaking out temperature
Rt = Maximum allowable increase in temperature of the mold after pouring
H = Height or length of the bushing

In permanent mold design the determining of the right wall thickness is a rather important element, because it directly controls the pouring schedule. As a rule the heavier the walls of the mold, coincident with ease of handling both at the foundry floor and the machine shop, the better. Massive molds permit a greater number of pourings in a given period of time, which means a lesser number of molds required for a given output of a certain pattern. Again the danger of the molds overheating to the point where they are difficult to handle even with hand leathers, is eliminated.

Temperature Affects Mold Life

Our experiments have shown us that the life of a mold is much shorter when the temperature of its mass runs above 850 degrees Fahr. after each pouring than the one which is heavy enough to absorb all the latent heat of solidification of the poured casting, down below its stage of brittleness, and stay below the 850 degrees Fahr. mark. Another advantage in massive walls is, that when the mold after a period of service develops fire cracks and becomes rough, it can be rebored or refinished, as the case may demand, at little cost and used again for casting bushings a size larger.

The formula for determining wall thicknesses given takes care of these requirements and while it applies in particular to the type of permanent mold illustrated in this article, it may be applied in general to all solid wall chill molds, and it may find useful application also in the design of water or oil cooled molds used more extensively in casting ferrous alloys. A good many breakages of molds made of gray iron can be traced to faulty design, overheating, and clamping or rigging these molds so tight they cannot expand. However, wrong iron composition with regard to carbon and silicon and poor foundry practice in casting these molds account for most of the failures after the molds have been in service for a while.

Gray irons as a class possess certain advantages over steel or copper as chill mold making material, which put them forward as the most suitable materials for that purpose at the present time. These advantages are: Low cost of manufacture; the graphitic carbon in them acts much like a facing material, such as plumbago is sand molding, tending to prevent the casting from sticking to the mold, and by the same token the necessity of applying on the face of the mold heavy dressing compounds which perforce contain objectionable volatile matter causing formation of undesirable gases is eliminated; gray irons are not apt to warp or get distorted from high heat as is the case with steel and copper.

Clamp Molds Lightly

Previously it was stated that one of the many causes of mold breakages was too tight clamping or rigging, preventing expansion. That, at least has been one of our many sad experiences. Several of the first mold failures were traced to that cause. Actually the mold should be clamped lightly, not any tighter than is necessary to prevent the component parts from springing apart and cause leakage or run outs while pouring. After this period, expansion of these parts from heat absorbed from the poured casting tightens them more and more, and it is important at this stage that the clamping rigging possess certain flexibility so as to give somewhat under the tremendous force of mold expansion. An easy way to accomplish this is to drive a wooden wedge lightly between the steel clamp and the mold. This provides a flexible clamping, and permits the mold to be *knocked down* easily. Compressed air also may be used to advantage to hold the parts of the mold together while pouring in place of steel clamps.

Before the mold is closed, at the start, it is preheated with an oil torch to a temperature around 250 degrees Fahr. Then a mixture of paraffine lubricating oil in which a small amount of lampblack or Ceylon graphite has been mixed thoroughly, is sprayed or applied with a brush over the face of the mold. The purpose of this application is two fold: First, the greasy matter of this lubricating oil forms a thin protective film on the face of the mold which acts in identically the same manner as does parting materials in the case of sand mold. Second, the evaporation of volatile matter in the oil cools the mold between pouring intervals.

Uses Coating

Heavy crude oils of coal tar base are not suited so well for mold dressing because the deposited pitch on the face of the mold after evaporation of the volatile matter in the crude oil sticks to the face of the casting, giving it a rather black, pitted, dirty appearance. Kerosene in which a certain amount of lampblack has been mixed makes a good dressing but is dangerous, due to the low flash point of this oil. Undoubtedly, when the use of permanent molds becomes a commonplace practice some enterprising individual will develop some kind of a mold dressing that will not explode when coming in contact with the hot mold, will not deposit objectionable residues requiring frequent mold cleaning, and will produce smooth castings.

With sand molding as every nonferrous foundryman knows, the pouring temperatures of brass castings are proportionate to the copper contents of the alloy. The higher the copper, the higher is the pouring temperature. The same rule applies to the permanent mold process except, that owing to the chilling effect of these molds, great fluidity of the molten brass is of paramount importance. For that reason the pouring temperature range when pouring in permanent molds is from 75 to 100 degrees Fahr. higher than the corresponding range of pouring in sand molds. In other words, the pouring of brass castings in permanent molds requires hotter metal.

By nature the average foundryman is rather negligent concerning pouring temperatures. He trusts too

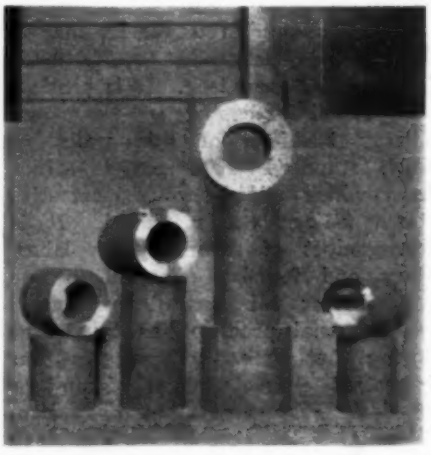


Fig. 9—Views of Permanent Mold Cast Bushings

much to the guess of his eye and he feels that a variation of 100 or 200 degrees Fahr. is of no consequence at all, yet the difference between a good and a bad casting often lies in such a temperature variation. With permanent molds the pouring temperature must be just right; a large variation one way or the other is apt to cause considerable trouble. Cold pouring will produce *red spot* (segregations of cupric and cuprous oxides), cold shots, wrinkles and draws under the riser and gate, and the fracture will show the characteristic little round holes of occluded gases. Too hot pouring will produce patches of honeycombed metal and difficulties from greater shrinkage.

At the start of filling the mold, the pouring must be done at a rapid gait with a large flow of metal. As the mold becomes filled, the pouring speed is slowed down in a continuous and gradual manner so that by the time the metal inside the mold reaches the riser, only a small stream of metal flows from the pouring ladle into the gate. The slowing down of the speed of pouring is necessary to provide a reservoir of as hot metal for as long a time as possible. This fills the casting during the setting period and avoids piping from shrinkage particularly when the alloy is high in tin and also provides a hot fluid passage for any entrapped gases. The importance of continuous pouring is obvious. A stoppage in pouring of a second or so will cause the casting to come out with a *cold seam.*

After pouring the casting is allowed to remain in the mold until nearly past its brittle stage, usually from 4 to 5 minutes. The molds then are opened, the castings taken out and their gates knocked off while hot, taken to the cleaning room where they are rattled, ground, and the risers sawed off. The inside of the mold is sprayed with the dressing mixture of paraffine oil and lampblack, closed and clamped; and it is ready for the next pouring. As a rule it takes only 10 to 12 minutes to pour, to shake out, and have the mold ready again for the next pouring.

Cost Is Reduced

Our experience of casting brass and bronze in permanent molds for the past four years has demonstrated clearly to us that all patterns of castings of design adaptable to that process of molding can be produced at a considerably less cost as compared with sand molding. Of course, the larger the casting the larger the reduction in cost of production, but the fine points of brass foundry practice in regard to melting are unaffected by this comparatively new molding process. To make good sound castings in permanent molds, the molten alloy before pouring, should be as in the case of sand molding, above suspicion. It is true, permanent molds eliminate porosity coincident with sand molding and improve on porosity from faulty melting. Still they should not be expected to change a bad heat into good sound castings, for that cannot be accomplished under any circumstances.

With permanent molds the alloys easiest to cast are those in which the white metals are high because in such cases the pouring temperatures are comparatively low and the danger of oxidation, of gas absorption from superheating the molten alloy at high temperatures as it is with the case of alloys high in copper and low in white metals, does not exist. This all around improvement concerning porosity should be appreciated greatly by foundrymen casting red brass alloys for steam fittings, or castings that must stand hydraulic and other pressure.

Produces Fine Structure

It has been said and believed by many, that the chilling effect of permanent molds imparts on lead bronzes physical properties imparted by tin in sand molding. It is true that the permanent mold increases the power of tin to *hold in* the lead. Also because of the surprisingly finer denser microstructure obtained in the alloy considerably less tin is required either to hold the lead in or to produce castings of close grain. However, the assertion that the permanent mold can produce high lead bronzes of low tin content that have the physical strength and other properties especially at elevated temperatures of low lead bronzes containing high tin, is altogether erroneous and should not be given consideration.

A foundryman making such a loose statement concerning lead bronzes, usually forgets to add that he is doping his alloy with considerable phosphor-copper or alloys of manganese-nickel base which in the long run may cost him more money than his savings from a reduction in tin contents. The author knows of several cases where this is true. The true value or benefit of the permanent molds comes from the fact that on equal conditions with sand molding, they produce better quality castings at lower production costs, the natural outcome of finer, denser, more homogeneous microstructure, and savings in molding labor and materials.

Book Review

Handbuch der Eisen-und Stahlgiesserei, Part 1, *Grundlagen*, edited by C. Geiger, imitation leather, 661 pages, 7½ x 11 inches, published by Julius Springer, Germany, and supplied by THE FOUNDRY, Cleveland, for $13 plus 15 cents postage, and in London from the Penton Publishing Co., Ltd., 416-17 Caxton House, Westminster, for £2 8s 5d, postage extra.

The first edition of this volume was published in 1911, and as its title designates is a handbook of iron and steel founding. Due to the advance in the industry a second edition was necessary to incorporate the changes and bring it up to date. The introduction to the book is by the editor C. Geiger, and this section is followed by a chapter on the story of iron and steel founding by the late Ludwig Beck. T. Cremer contributed a chapter on statistics relating to iron and steel foundries while Prof. O. Bauer discusses the metallurgical chemistry and metallography of iron. Data relating to pig iron and its production was supplied by Gieger and R. Durrer describes ferroalloys and other addition metals. Information on cast iron and steel scrap was contributed by J. Hornung, while S. J. Waldman describes the briquetting of iron and steel chips. C. Irresberger discusses cast iron and charge make-up, and steel is discussed by M. Philips. Malleable cast iron is the topic of a chapter by Rudolf Stotz, and the important properties of castable irons and their dependence on the chemical composition is described by G. Hellenthal. Strength properties and physical testing of cast iron is discussed by G. Fiek. Combustion and fuels are subjects of chapters by Georg Buzek and C. Geiger. Temperature measurements in foundry work is described by K. Daeves while refractory materials are discussed by Fr. Wernicke. Two chapters by C. Irresberger on molding materials and fluxing materials are followed by the concluding chapter on chemical investigations of raw materials and finished products of the foundry by A. Stadeler. The volume is indexed according to subject matter and contains an appendix of 10 plates showing micrographs of different structures.

Organize Sand Company

Eugene W. Smith Inc., Evansville, Ind., has been organized to handle a line of foundry molding sand. The company expects to place a new mill in operation on Aug. 1. Eugene W. Smith Jr., is general manager of the company.

Applies Scientific Data

To Problems Encountered in Foundry Work

Progress Made in Testing of Molding Sands Aids Foundrymen in Controlling Molding Operations and Reduces Number of Defective Castings

By Frank Hudson

IT HAS been said that a greater proportion of defective castings can be attributed to bad cupola practice than to the actual casting and making of molds and cores. Such a statement is open to grave doubts. An unbiased consideration suggests that the greater number of defective castings produced in most foundries is due to poor and badly supervised pouring and molding operations. That department calls for more of the *human element* than any other foundry operation, and consequently is open to mistakes and miscalculations. However, in the past few years the foundryman has had placed at his disposal definite means of controlling several of these variables. Increased use of machine molding, systematic study of sand preparation and handling equipment, efficient drying stoves, sand and core testing, and control apparatus, have helped enormously to minimize rule of thumb methods.

The testing of foundry sands and molds is yet in its infancy, and every credit is due to the American Foundrymen's association for its work in this direction.

Ideal sands exist for every foundry, according to the method of molding, and the class of castings. However, the ideal never can be reached by chance and only becomes apparent by those who make an attempt to study and test molding and core sands. The apparatus adopted by the American Foundrymen's association, or that developed by the author, and described in the *Foundry Trade Journal*, April 12 and 19, 1928, have been devised essentially to help the practical man, and by their use it is possible to gage the true value of foundry sands and guarantee successful casting production. On the other hand, sand testing and control paves the way to the elimination of defective molds, and gives a means for correction.

The mold hardness tester used by the author consists of a brass baseplate supporting a bearing in which slides a plunger. At the top of this plunger is a loading table, while at the bottom a ¾-inch diameter steel ball is embedded. Surrounding the bearing is an ebonite ring having copper contact points at the top, this serving both as a distance stop for the ball penetration, and also for coupling up with a small electric lamp and battery as an indicator when maximum ball penetration has been obtained. The principle of the test is to apply weights to the table until contact is made on the ebonite ring when the lamp lights. At full load the ball is embedded in the mold up to half its diameter, namely, ⅜-inch. The hardness index of the mold under test is expressed by the weight required to embed the ball plus 2 pounds, which is the weight of the table and plunger. The use of this instrument gives an index of the amount of ramming applied and the variations existing in molds and cores due to that ramming.

The green dropping test sampling tube consists of a brass tube with a knife edge at one extremity, and a cap at the other, having a slow thread screwed hole, in which works a long spindle attached to a piston. The cross-sectional area of this tube is exactly 1 square inch. The method of using this tube consists in screwing back the piston to the closed end and pressing the open end into the mold, and extracting a sand sample. Upon ejecting the sand in a horizontal plane by the piston and measuring the *overhang* after fracture of the sand has taken place, an index of the bond strength is obtained.

In the mold permeability test, the small sampling tubes illustrated are pushed into the mold and placed in the aspirator which draws a standard volume of air through the sand under test. This apparatus consists of a cylindrical aspirator vessel connected to a brass test-piece holder. A complete operation for testing a green sand mold is as follows:

The permeability sampling tube is greased inside and pressed into the mold. After extracting, the ends are leveled and the outside of the tube cleaned and coated with grease. (Grease is used for obtaining air-tight connection.) The cock at the base of the aspirating vessel is now closed and the two top ones opened. Water is poured into the holder until the vessel is full as shown by the water gage. Both these cocks are closed, and the bottom cock opened. The sampling tube is placed inside the holder and the cock at the base of holder *X* opened, when the water escapes and air is drawn through the sand sample. The time in seconds for the water to drop from the top of the water gage glass to the bottom is an index of the permeability of the sand. For dry sand samples the mold is sampled in a similar way when green, and the mold and sample dried together. After drying, the sand sample is extracted from the tube. The inside of tube is coated with thick grease, and the sample replaced and the test completed as described.

The moisture meter is a modification of the electric resistance method, and is based upon the principle of measuring the electric current passing through damp molding sand, the intensity of the current varying according to the amount of moisture present. The assembly consists of a galvanometer, battery and resistance board.

Controlling Operations

A GREAT many defective castings result from badly supervised molding and pouring operations. Many of the variables in molding and pouring which may be controlled by the foundrymen are discussed in this article, which is the second of two abstracted from a paper presented at the Chicago meeting of American Foundrymen's association. The author is chief metallurgist, Glenfield & Kennedy, Ltd., Kilmarnock, Scotland.

This latter consists of a mold 2 x 2 x 6 inches, containing 2 cupro-nickel electrodes 5 inches apart. Attached to the board is a jolt-ramming device. This is to insure uniform packing conditions of the sand in the mold. The method of using is to pass the sand sample through an ⅛-inch riddle, and then fill the mold box without any ramming to the sand whatsoever. After leveling the top, the box is given 30 jolts, and the deflection of the galvanometer noted, which is an indication of the moisture content.

However, it is important to note that every different type of sand must be standardized on this instrument against a chemically conducted determination.

An interesting point came to light in experiments on this apparatus. It was noted that when a dried sample was tempered with water, the galvanometer deflection was much greater on a freshly tempered sample than on the same sand sample after standing several hours with a uniform moisture content. This would appear to have some bearing upon the fact that most molding sands exhibit superior physical properties after being allowed to stand after tempering, the reason probably being due to the fact that the clay or other colloidal bond around the sand grains does not develop its correct bonding power until a certain time has elapsed, and the added water has had time to uniformly penetrate the bond coating. At the same time it is quite probable that testing molding sands for electrical resistance will give a good indication of their heat conductivity.

A mold is made in which the experimental sands are used in 2-inch wide blocks to form the base. The mold is cast with hot iron, and from the resulting casting, the refractoriness of the sands can be gaged according to the amount of sand fritting which has taken place, and the skin producing powers readily shown after sandblasting.

By testing the molds as described, and following the resulting castings through the final stages of manufacture in the dressing and machine shops, it is not a difficult matter to draw up the necessary properties required of a mold and cores for successful casting production. For example, the specifications of Table II have been obtained for brass and gray iron castings.

Molds having these physical properties will produce satisfactory castings in the hands of skilled molders, although it should be pointed out that in this specification it would be advantageous to increase the bond strength to prevent scabbing and cutting when the sand is worked by unskilled labor.

Table II

Green Sand Mold Specifications

(Hand Rammed)

Brass and Gunmetal Castings (i.e., stop cocks, sluice valves, valve seat rings, sluice faces, hydrants, etc.).

Mixture	Parts	Moisture content, per cent	Mold hardness, pounds	Bond strength, inches	Permeability seconds
Belfast Red Sand	100	7	16-18	1.5	120

Gray Iron Castings (i.e., sluice valves, standposts, handwheels, water meters, sluice frames, etc.).

Mixture	Parts	Moisture content, per cent	Mold hardness, pounds	Bond strength, inches	Permeability seconds
Floor Sand	8	7	19-22	1.8	80
Drumcavil Rock Sand	4	7	19-22	1.8	80
Wormit Red Sand	3	7	19-22	1.8	80
Coal Dust	1	7	19-22	1.8	80

However, it is essential to have some such specification based on actual practical results, for a starting basis to obtain mold and sand control, keeping the facts in mind that consistent with the necessary sand texture the higher the bond strength and the greater degree of permeability, the more fool proof becomes the sand for practical application. An ideal sand should have the following characteristics:

Spherical one sized silica grains to give permeability.

A predominating grain size, fine for finish, coarse for refractoriness.

Just sufficient bond coating each spherical grain to give the necessary strength without impairing the continuity of the pore spaces.

A careful consideration of these points by the practical man, and by the use of sand testing equipment, will supply material for rapid progress, better and cheaper castings, and greater efficiency. Knowledge of the following points, in definite figures which can be immediately applied to practical application become available:

1.—The effect of sand preparation machines.

2.—The most suitable sand mixture for casting production.

3.—The most economical sand that can be obtained.

4.—Sand mixtures to increase production. (For instance, self-venting sands.)

5.—Reclamation of old sand.

6.—Effect of the different molding methods. (Machine versus hand.)

7.—Elimination of defective castings from mold defects.

8.—A working knowledge of the relative values of each molding sand.

Surely these advantages give more than ample reason for the universal immediate progress of sand testing, and greater intimate co-operation between science and practice.

The adoption of oil sand cores to foundry practice is one of the biggest benefits to the practical man in recent years, and it is surprising how many foundries do not avail themselves of the benefits arising from their use. The advantages obtainable over other dry sand cores can be stated as follows:

1.—Strength and permeability unaffected by variations in ramming.

2.—Freedom from scabbing and causing blow-holes.

3.—Increased production in fettling.

4.—Lower drying time with decreased coke consumption.

5.—Increased production.

6.—Ease of mixing.

7.—Little volume change after drying.

8.—Good skin produced on casting without use of blacking.

9.—Saving in core irons.

10.—Easily handled after drying.

11.—Promotes softer skin on casting and lowers machining difficulties.

Here again the full benefits of oil sand core practice can be obtained only by co-operation between science and the practical man. For instance, the number of core oils offered to the foundry trade today demands that all should be tested in regard to strength against quantity required, and consequent cost of mixture. Different oils require variations in drying schedules and impart entirely different characteristics to the sand mixture when green. For instance, cores which require to be made in halves when using a plain, linseed-oil, sea-sand mixture could be made in one piece by the use of a different oil or by the inclusion of a bonded sand. It would seem, however, that much of the simplicity of oil sand is lost by the inclusion of a bonded sand as the mixture becomes more susceptible to ramming effects, has less permeability, and requires more oil for a given

strength. A great deal of valuable practical information can be obtained by using a modification of the sand testing apparatus for testing oil sand core compositions. In this respect the suggested test methods would consist of tensile, transverse and permeability tests conducted on dried samples, with a green dropping test to give an index of the bond strength before drying.

For tensile tests, use was made of the standard cement mold having exactly 1 square inch section across the neck, the resulting test piece being fitted with the necessary grips so that it could be broken by weighting or by the use of a cement tensile testing machine.

Transverse test consisted of a suitable core box to produce a test piece 6 inches long by 1 inch square, which was broken by suspending a load from mid-center from a ¼-inch round shackle, the breaking center being 4 inches apart.

Permeability was conducted as described previously.

In the green dropping test the sand is rammed up in a skeleton core box on a ⅜-inch thick glass plate to give a bar of sand 1 x 1 x 12 inches. The glass plate projects over the edge of a bench, and the sand is pushed gently over the edge of the plate until the sand collapses. The length remaining (measured from the middle of the fracture), subtracted from the original length is recorded as a measure of the bond, the average of at least 4 tests being taken.

All test pieces are dried at 350 degrees Fahr. and a standard silica sand used for mixing. Little trouble is experienced from ramming variations due to the nature of these mixtures, and concordant test figures are obtained easily.

Table III gives an example of the application of such tests to oil sand compositions. A matter of particular note is the large variations in core strength due to differences in quality of the linseed oil. The value of these tests for controlling core oil quality is obvious. From these tests it is also interesting to note that mixtures can be produced readily that will give considerable bond in the green condition which is often of considerable help for certain classes of cores.

Table III

Standard Sand Sieve Test

(Irvine Sea Sand)

Mesh No.	20	30	40	60	80	90	100	120
Per cent passing	96.59	94.01	90.97	77.85	26.89	14.42	9.85	1.72

STRENGTH AND PERMEABILITY TESTS

Mixture	Green dropping test, inches	Tensile strength ozs. per sq. in.	Transverse strength, ozs. per sq. in.	Permeability seconds
Sea Sand. 2 per cent boiled linseed oil (Baltic)	1.1	1921	442	51
Sea Sand. 2 per cent boiled linseed oil	....	1541	732	50
Sea Sand. 4 per cent boiled linseed oil	....	4780	1918	48
Sea Sand. 1 per cent boiled linseed oil	....	4502	1248	52
Sea Sand. 2 per cent pale boiled linseed oil	....	255	105	40
Sea Sand. 2 per cent boiled linseed oil	....	11	4	40
Sea Sand, 40 lbs. Semi-solid core-compound, 2 lbs.	2.5	2722	805	57

All samples baked at 350 degrees Fahrenheit, except green dropping test, which is tested green.

Within recent years core oils have been added to loam jobs, and as a result less cracking of the mold surface is apparent after drying, and consequently less risk of defective castings.

Some years ago the author did some work in this direction. The following mixture for loam work was prepared in a light pug mill:

2 large shovels sea sand.
½ large shovel floor sand.
½ large shovel Erith loam.
¼ large shovel cow hair.
2 pail-fulls linseed oil compound.

The oil compound consisted of 1 part water, 1 part boiled linseed oil, and a small quantity of ammonia to promote saponification. The mixture was milled for 10 minutes, watered to the correct consistency and then dried at 350 degrees Fahr. for 6 hours, when the following results were obtained on the sand testing apparatus:

Transverse, 1524 ounces per square inch.

Permeability, 992 seconds.

For comparison with these figures, the following was representative of ordinary stiff fine loam: Dried at 450 degrees Fahr. for 4 hours:

Transverse, 511 ounces per square inch.

Permeability, 1230 seconds.

The advantages of the oil addition were an increase of nearly 300 per cent in strength, better permeability to the extent of approximately 20 per cent, and freedom from drying cracks.

It would appear that the full knowledge and advantages of core oil used for foundry service have as yet only been touched upon, and the future will see wonderful progress in this direction. The reclamation of old cores and burnt core sand is another important matter. The burnt material makes an ideal parting sand, and can be used to open up green sand molds by incorporation with the sand mixture. It can also be adopted by remixing with a suitable core compound for dry sand facing purposes. Old cores can be passed through a rotary kiln, and the oil and carbonaceous matter removed by burning. Then the product is equal to new core sand. This should receive attention by those founders who have to transport core sand from long distances and carry heavy freight charges. The matter becomes a practical proposition when freight charges are treble the cost of the sand at the pit.

Successful oil sand practice essentially depends upon the use of good drying stoves. This point often is overlooked by the practical man. Oil sand dries by oxidation. It is not just a question of removing moisture. The most successful way to bake cores is by the use of low temperature with good air circulation inside the stove. In fact, this also applies to drying sand molds and cores in the foundry. One has only to notice how rain soaked pavements and streets dry just as quickly under the effects of a good breeze without sunshine, as on the warmest of calm summer days to appreciate, and understand this point. A temperature of 400 degrees Fahr. is amply sufficient to cover the drying of oil sand cores, and the quickest drying time with greatest stove efficiency is obtained by a good inside stove circulation. For this purpose the most flexible practice is to use an exhaust fan instead of the usual smoke stack or chimney.

In conclusion, it should be clearly understood that the aim of the metallurgist is to help the practical man, and each should respect the others' efforts. The price of safety in foundry work is eternal vigilance, which can be obtained only by suitable control made possible by a mutual understandable basis of *science* hand in hand with *labor*.

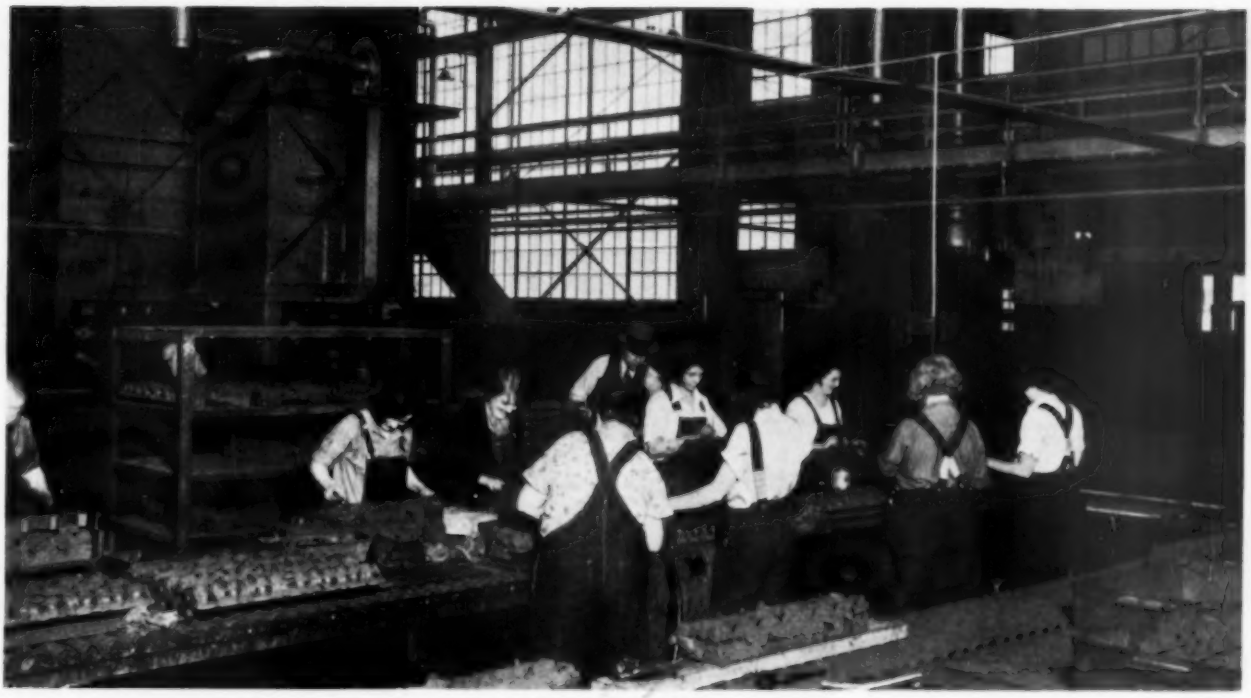


Fig. 1—The Various Component Parts of Cylinder and Cylinder Head Cores Are Fitted, Assembled, Jigged and Inspected on Roller Conveyors

Speeds Production of Cores

New Foundry of Oakland Motor Car Co. Features Interesting Methods and Equipment for Making Cores for Automobile Castings

By Pat Dwyer

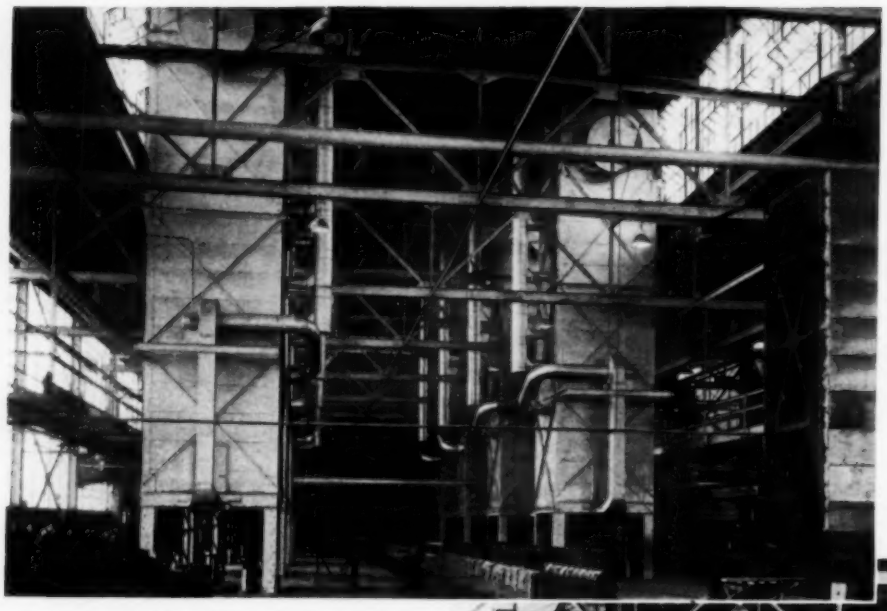
PROPER recognition of its importance as one of the main departments has been accorded the coreroom of the foundry recently erected by the Oakland Motor Car Co., Pontiac, Mich. Instead of the partition, in some instances real and in others purely imaginary, that separates the foundry from the coreroom in the average foundry, this particular coreroom is housed in a building by itself, separated from the foundry by a court on the south, 80 feet in width, and from the cleaning room on the west by another open space 60 feet wide.

Ample light is secured through windows that take up the greater part of the side and end walls, also from continuous skylights in the roof. The floor is laid smoothly in cement as compared with the wood block floor in every other department. Traffic is light in the coreroom and this type of floor lends itself readily to a general order to keep floors clean at all times, part of a safety first campaign which now is in force throughout the entire plant of the company.

New sand in three varieties for the cores is stored in a series of concrete bins in a building adjoining the coreroom on the west. Two of these sands are of the clean washed lake species indigenous to Michigan and used extensively all through the middle West. The third is a bank sand containing a small amount of natural bond. Water jacket cores and small intricate cores from which the gas must escape almost instantaneously, are made from the lake sand bonded with oil. Large cores, subject to distortion while in the green state are made from a mixture of lake and bank sand also bonded with oil. The bank sand supplies the necessary strength to prevent the green core from sagging.

A section of 1¼-inch steel pipe, freely perforated serves as reinforcement in each of the barrel cores. The upper part of the crankcase and the six barrels of the cylinder block are formed by a large core made in two sections with three barrels to a section. In addition to the pipes, a few small rods are placed in the core at points where reinforcement is needed.

Although some of the other cores are made without wires and some only carry one or two, still the total number of cores made daily is so large that a special room has been fitted at the north side of the building for preparing the wires in the required shapes. To a considerable extent old wires are reclaimed and rebent in forms provided for the purpose. New wire in several gages is taken automatically from the coil in several ingenious machines, cut to length, bent to any desired shape and deposited in boxes which later are taken to the various coremaking stations. The wire room is located in the western end of a long general service building, containing a store room for miscellaneous supplies, a general repair and maintenance shop, a pattern shop and a shipping room from which the castings are despatched by truck to the next department.



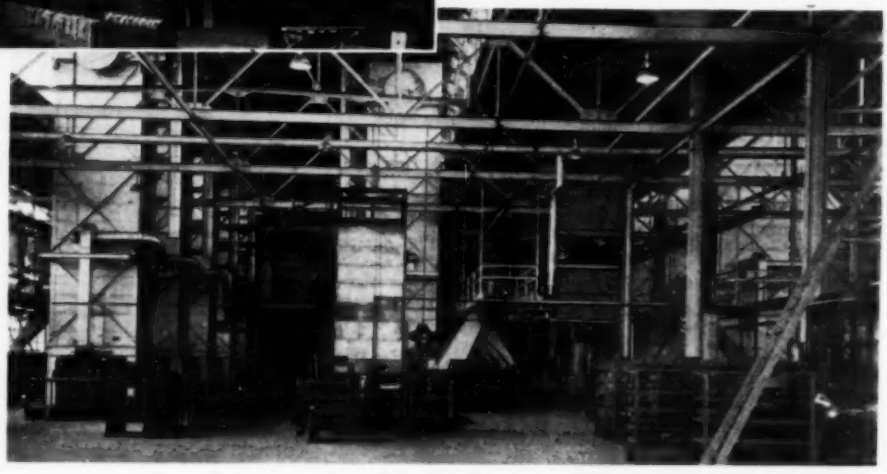


Fig. 2 (Above)—General View of Two Batteries of Ovens at an Early Period Before Production Started on an Appreciable Basis. Fig. 3 (Right)—Spouts from Overhead Hoppers Convey the Sand to the Coremakers' Stations

In the first of this series, published in THE FOUNDRY, July 15, reference was made to the general layout of the sand storage building and to the manner in which incoming sand is lifted by a 2-cubic yard grab bucket suspended from a crane made by the Whiting Corp., Harvey, Ill. This crane is equipped with four motors, two drums, one for the holding line and one for the closing line, and herringbone gearing, a feature recently developed by the Whiting Corp., and incorporated in all its new cranes.

The same crane and bucket are utilized to replenish three 20-ton steel hoppers mounted above three revolving paddle type mixers made by the Standard Sand & Machine Co., Cleveland, and capable of delivering 25 tons of mixed sand per hour. Space is available for a fourth unit in the event it is required to meet increased production schedule.

Each mixer is motor driven through a spur gear speed reducer. Each storage bin is equipped with an air operated measuring gate which deposits a given amount of sand in the mixing trough for each batch. Mechanical devices also regulate the amount of oil and water and the elapsed time the mixture is in a state of agitation. The variable human element has been taken out of the operation with the result that the sand always is uniform.

In an emergency or in the event that the conveying machinery temporarily is out of commission, the mixed sand may be discharged through the bottom opening of each mixer into a wheelbarrow or truck. Normally the sand falls through an opening in the floor upon a belt conveyor which in turn discharges it into the boot of an elevator. The elevator takes it aloft to a large storage bin from which it is distributed to the various coremaking stations in a bucket suspended from a monorail. An operator travels with the bucket, switches it to any desired location and is responsible for keeping a supply of sand in the hopper above each coremaker's bench or machine. Distributing equipment was fabricated and installed by the Chisholm & Moore Hoist Corp., Buffalo.

Many Units Installed

Conservation of floor space is claimed for the general layout in the coreroom where each of the 16 vertical ovens serves as the center for a group of coremakers. Each oven 7 feet 10 inches x 9 feet 4 inches outside dimension, extends upward 45 feet above the floor level. These ovens made by the Detroit Sheet Metal Works and the Palmer-Bee Co., Detroit, are of the continuous type. The cores are placed on swinging racks at a convenient point near the floor level. The racks travel upward through a gradually increasing temperature and then descend on the opposite side through a falling temperature to a point where they are removed. Through suitable reduction gearing the speed of travel is regulated to pass the cores through the oven in the ideal period required to bake them properly.

The ovens are constructed of rock wool insulated steel panels within the structural steel skeleton. In certain ovens the carriers are single decked. In others they are double and in a few instances triple decked. The trays are open grates. Oil is burned in a central, refractory, combustion chamber and the heat is distributed through and into the oven by a series of dampered baffles arranged for considerable flexibility of heat control through each of the various zones. On the down journey the cores pass through a cooling chamber through which the air is drawn by a fan. This current picks up hot air from the cores and passes it into the windbox surrounding the combustion chamber from which it passes into the dilution chamber and thence into the oven with the hot gases of combustion from the oil burner. Other advantages claimed for this type of oven are that it creates no smoke or fumes and that it requires no exhaust fan as it is vented by natural draft. Recirculating air at approximately 275 degrees Fahr. exerts an appreciable effect on the oil consumption.

Interesting test data on the performance of one of these ovens baking flywheel housing cores, gear case cores and tappet housing cores under operating conditions are shown in the accompanying illustrations Figs. 6 and 10. The first core weighs 14 pounds, the second 9½ pounds and the third 29 pounds. Loaded in the manner in which they came from the core

machines the oven contained 113 of the first cores, 50 of the second and 60 of the third, a total weight of 3797 pounds. Fig. 9 shows the time, temperature and travel chart for one complete cycle through the oven.

Oil was measured in a metering tank for five ovens over a period of 8 hours beginning after each oven was up to operating temperature of 450 degrees Fahr. and was found to be 115 gallons, or 6.3 gallons fuel oil per ton of dry cores. Prorated on a yearly capacity and allowing sufficient oil to bring the oven up to the proper temperature once each week over that period, the consumption of fuel oil works out at 6.5 gallons per ton of dried cores.

In the heat chart shown in Fig. 9 the dotted line shows the stationary element in the oven. The dot and dash line shows the element placed on a tray during one complete cycle. The dash line shows the heat penetration through the core as it made one cycle. In this instance the sensitive bulb was placed in the center of the core.

Vertical core ovens have been installed elsewhere, but it is claimed this is the first foundry where they have been adopted exclusively. Also it is stated to be the largest installation of its kind in existence. Each of the 16 ovens contains 32 racks and each rack is designed to support a load of 500 pounds of cores. Fourteen of the ovens are driven in pairs. The two remaining ovens are driven individually. The head shaft of each oven is equipped with drive sprockets on each end, thus eliminating the immense torque which would be evidenced if driven from one end. The sprockets are connected to a countershaft through a roller chain drive. The countershaft is connected to a herringbone speed reducer through a roller chain drive at a ratio of 6 to 1. The speed reducer is coupled to a worm gear by a mill type coupling. The high speed shaft of the worm gear is driven by a chain drive from the motor.

Describes Features

The supporting structure presents an interesting feature in that the corner angles which form the columns of the supporting tower also form the corners which support and form the corners of the oven. The panels are bolted to the legs of these angles.

Another new feature, one that it is claimed never has been used before in this connection, is that the ovens are equipped with take-up curves instead of the conventional sprockets and shaft. With this arrangement the core racks may be loaded between parallel strands of the conveyor. The take-up curve floats between vertical guide angles thus compensating for contraction and expansion of the chains. This form of construction eliminates the necessity for inspection and repair pits around the conveyor. These conveyors were designed and installed by the Palmer-Bee Co., Detroit, which also supplied the structural steel frames for ovens and conveyors.

Assembled core units pasted and blacked are dried in three vertical ovens conforming in many respects to the ovens just described and made by the same firm. However, they differ radically in two main features. The operating cycle is only 25 minutes and the shelves are moved vertically and horizontally in a series of short jumps hydraulically, rather than in the slow, steady movement which characterizes the electrically operated ovens. The operating gear including the valves, piping, motor and pump for one of the ovens is shown in Fig. 4.

The interior of the oven contains two columns of individual shelves, each column supported on the bottom by hydraulic plungers. A pusher at the top and another near the bottom effect the exchange of shelves at these points. The operation of the oven will be grasped more readily by following the progress of one plate of cores.

The operator, as shown in Fig. 4, places the core on a roller conveyor and pushes it into the oven where it comes to rest on one of the shelves. A synchronized movement of the hydraulic equipment, pushes the shelf upward one space, lowers the corresponding shelf on the opposite side a similar distance, pushes a shelf laterally on the bottom to take

Fig. 4 (Left)—Showing General Features on Operating Side of Hydraulically Operated Oven. Fig. 5 (Below)—Girls Are Employed Extensively in the Core Assembling Department

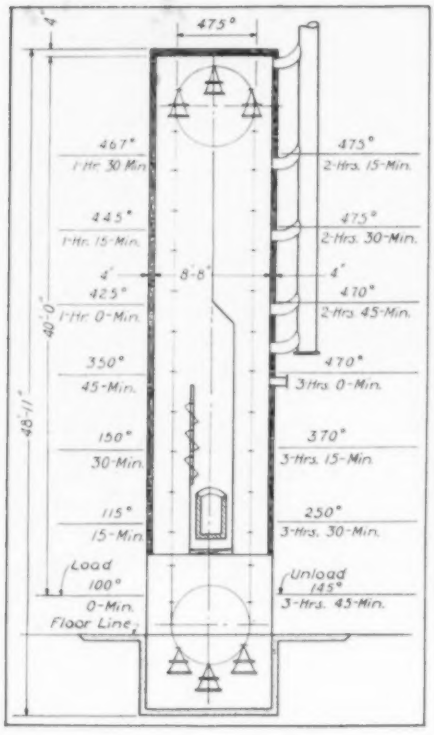


Fig. 6—Sectional Vertical View of Oven and the Elapsed Time and Temperature Range for a Complete Cycle

the place of the first shelf and pushes another shelf laterally on the top to take the place of the one which has been lowered. Instead of a number of shelves linked together to form an endless chain passing over sprocket wheels top and bottom, this oven is equipped with a series of individual shelves which move upward as a column at one side of the oven and downward as a column at the other side. Exchange of shelves from one column to the other, also continuity of operation is effected by the simultaneous movement laterally of the shelf at the top and the shelf at the bottom at any given time. Thus any given core moves upward through the oven in a series of jumps. At the top it is pushed across to the opposite side of the oven and descends in a second series of jumps or steps. At the bottom it is removed and the shelf is pushed across to the opposite side of the oven to begin another cycle. An automatic timing device regulates the movement of the various hydraulic plungers so that the shelves move in proper sequence: One up, one across at the top, one down and one across at the bottom. This method of operating a core oven, the conception of J. E. Linabury, foundry manager is attracting considerable attention. Naturally its merits and defects, if any, cannot be evaluated properly until after it has been in operation for a considerable period. Early and experimental runs have been quite satisfactory.

Assemble the Cores

All the cores with the exception of the combination crankcase and barrel core are made on small rollover machines from the International Molding Machine Co., Chicago. Certain groups of these machines have been located in a complete, or in some instances, a part square formation surrounding each of the vertical ovens. A double spout hopper replenished from above, supplies sand to the bench in the vicinity of each pair of machines. Dried cores are taken on roller conveyors to the assembly stations where they are inspected, fitted, pasted and blacked. Pasting and blacking take some of the cores to the hydraulically operated ovens. After the final inspection and assembly they are stored on portable racks until the racks are taken on lift

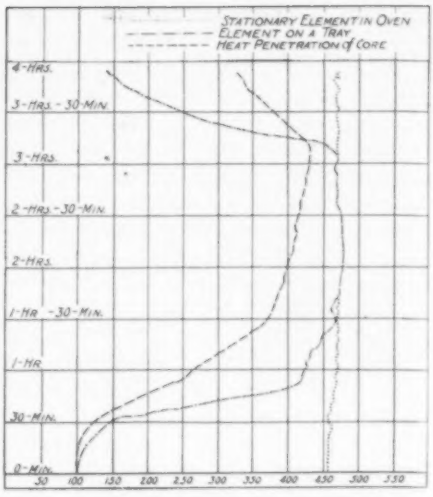


Fig. 9—Typical Heat Chart Showing Penetration

trucks to the foundry. These racks are provided with several decks made up of thin steel sheets supported at the ends. The sheets spring easily and thus absorb any shocks incident to inequalities in the roadway. The coreroom is smoothly floored with cement, but all other departments are floored with wood blocks. A brick floor is laid in front of the cupolas.

Combination crankcase and six-barrel cylinder cores are made in two sections on machines made by the Grimes Molding Machine Co., Detroit. The accurately machined metal corebox in several hinged sections and attached to one of the jolt rollover machines is shown in Fig. 7. The illustration shows the last stage in the production of a green core with the two core parts lowered away from the corebox and ready for removal to the oven. In the beginning, the corebox occupies a position the reverse of that shown. The crankcase part is above the barrels. After

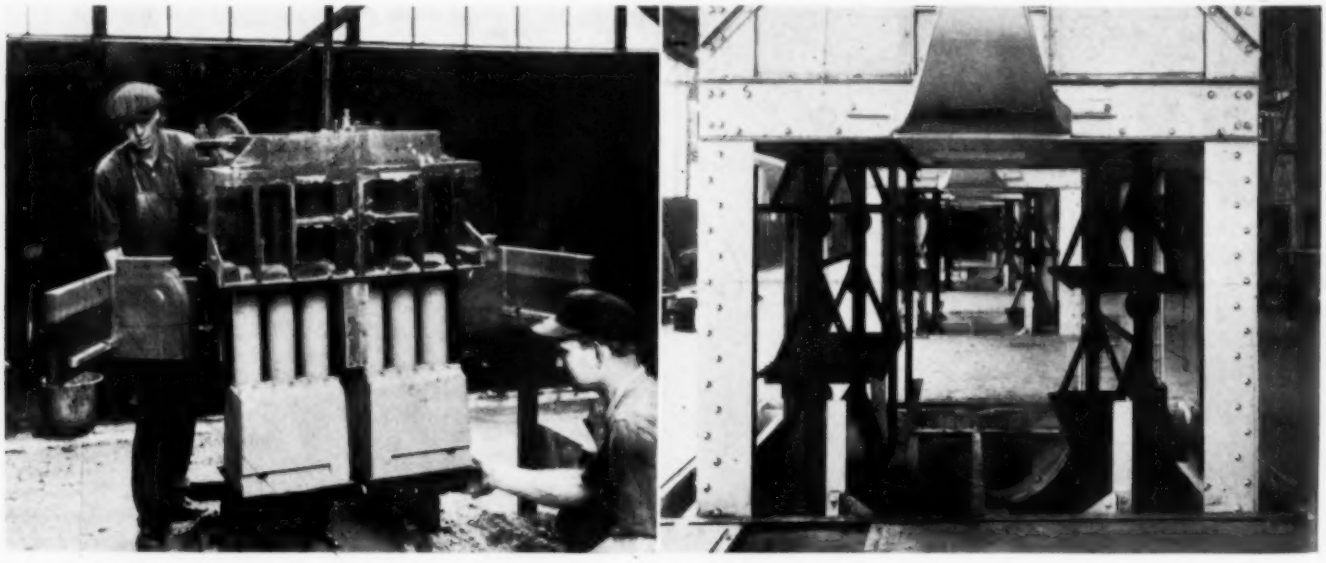


Fig. 7—Combination Crankcase and Barrel Cores Are Made in Two Sections in a Hinged Metal Corebox Mounted on a Rollover Jolt Machine. Fig. 8—Lower Part of Each Vertical Oven is Located Below the Floor Level

the straight plug to form the runner opening and the pieces of steel pipe to reinforce the barrels have been placed, the box is filled with sand from the overhead hopper and jolted. The top is scraped off flush and a number of vent holes are punched. Then the bottom plates are clamped in place automatically and the entire assembly is rolled over. The corebox is attached to the machine by a center pin and the center of gravity has been adjusted in such a manner that the assembly is rolled without effort. The clamps then are released, the runner plugs are drawn, the sides of the corebox are swung outward and the cores on their supporting plates sink by gravity away from the fixed corebox. The cores are lifted into one of the nearby ovens. The corebox parts are reassembled the entire assembly is swung through an arc of 180 degrees and the cycle of operations is repeated.

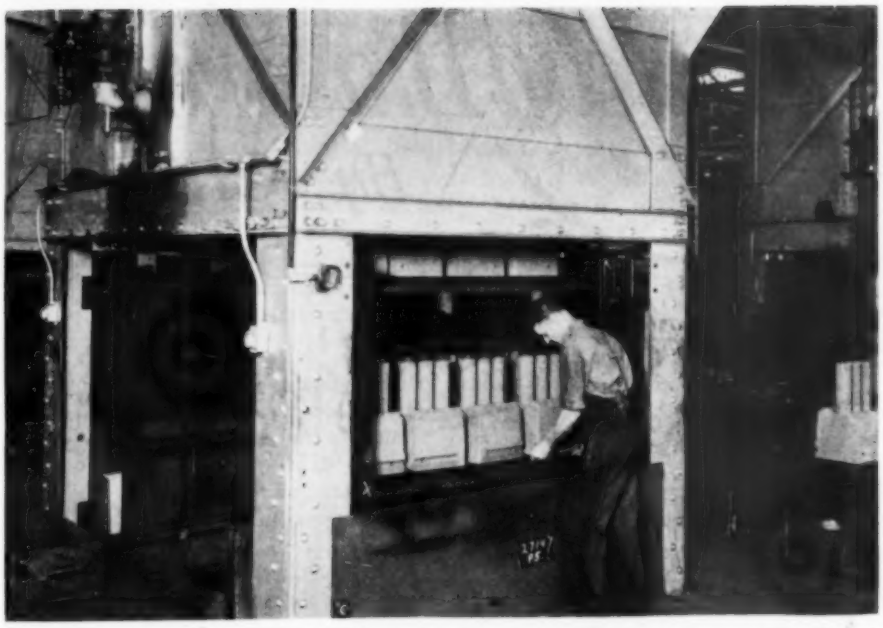


Fig. 11—Each Shelf of the Vertical Ovens Is Designed To Carry a Weight of 500 Pounds

This is the third of a series of four articles describing in considerable detail plant, equipment and methods employed at the new foundry recently erected and placed in operation at Pontiac, Mich., by the Oakland Motor Car division of the General Motors Corp. The fourth and concluding article in the series will be presented in an early issue of THE FOUNDRY.

Publish Proceedings

The Pennsylvania State college, State College, Pa., recently has published the papers and discussions which were presented at its second industrial electrical heating conference held under the direction of the department of engineering extension. The bulletin which is designated *Technical Bulletin* No. 21 contains 122 pages which are devoted to the presentation of papers by 14 authors. The papers described the application of electric heating to the electric melting of steel, brass and gray iron, electric annealing, carburizing and heat treatment; electric galvanizing, and the description of various types of electric heating furnaces. The price of the bulletin is $1 and may be obtained from the school of engineering, Pennsylvania State college, State College, Pa.

Appoints Directors

The advisory committee of the American Standard association recently announced the appointment of the associations' first board of directors as the final step in the administrative reorganization of the American Standards committee, the predecessor of the American Standards association. The board, which will control the general policies and finances of the association, will have the following membership: Quincy Bent, vice president, Bethlehem Steel Co.; George K. Burgess, director of the bureau of standards; Cloyd M. Chapman, vice president, American Standards association; C. L. Collens, president, Reliance Electric & Engineering Co.; Howard Coonley, president, Walworth Co.; L. A. Downs, president, Illinois Central railroad; Bancroft Gherardi, vice president, American Telephone & Telegraph Co.; F. E. Moskovics; W. J. Serrill, president, American Standards association; C. E. Skinner, junior past president, American Standards association; M. S. Sloan, president, New York Edison Co.; and R. J. Sullivan, vice president, Travelers Insurance Co.

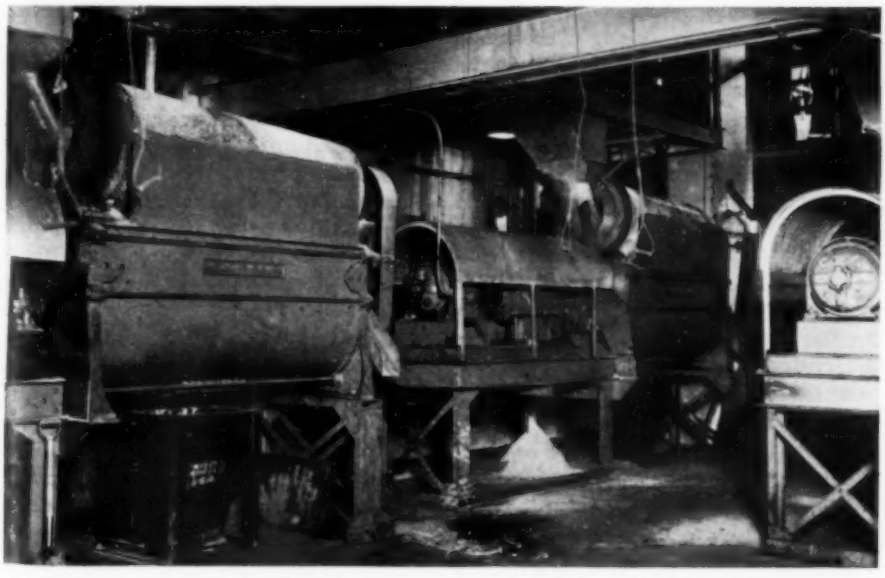


Fig. 10—Core Sand Is Mixed in a Battery of Three Individually Operated Paddle Type Mixers Located Under 20-Ton Storage Hoppers. Sand, Oil and Water Are Measured Mechanically

Sends Good Wishes

Oliver Stubbs whose illness prevented his greeting the overseas delegates during their visit to Manchester prior to the Third International Foundrymen's Congress has requested THE FOUNDRY to express his appreciation and gratitude for the inquiries and kindly expressions of his friends and his regret at being unable to meet them in his home city.

Builds Plant Addition

Farrell-Cheek Steel Foundry Co., Sandusky, O., is building a new addition 60 x 100 feet to provide facilities for its rapidly increasing business. The new building runs east and west and is a part of the present structure. Other plans for additions are under consideration and may materialize in the near future.

American Brass Foundry Practice

By Charles Vickers

Part III—Difficulties in Casting Yellow Brass

YELLOW brass is a more difficult alloy to cast in sand molds than is red brass or the copper-tin alloys, as it gives off a disagreeable smoke of zinc oxide which pollutes the atmosphere. It also produces dirty castings if the stream of metal entering the mold is not controlled so that the condensed zinc smoke floating on the surface of the alloy is prevented from entering the mold with the metal. In comparison with red brass, yellow brass as it enters the mold gives off an immense amount of vapor consisting of steam, hydrogen and volatilized zinc oxide, which ignites explosively as it emerges from the flask joints and the vents. Pouring off, in the case of this alloy is attended by considerable fuss, fumes and noise.

Is Above Boiling Point

Highly heated zinc admixed with copper, is the cause of all this commotion due to the comparatively high melting point of the latter. The temperature of the zinc is higher than its boiling point of about 950 degrees Cent.; (1742 degrees Fahr.). The melting point of copper is 1083 degrees Cent. (1981.4 degrees Fahr.). An alloy of 67 per cent copper; 31 per cent zinc; 2 per cent lead melts at 895 degrees Cent. (1645 degrees Fahr.), according to Gillett and Norton, *Transactions*, Institute of Metals, 1913, but the pouring temperature of such a brass is considerably above its melting point, and is thus higher than the boiling point of the zinc it contains. Therefore the latter distills out as zinc vapor, which in contact with the air in its highly heated form is oxidized immediately, producing the well known fumes.

The same reaction within the moist mold results in zinc oxide smoke and also considerable hydrogen. The latter igniting with explosive force causes the noise. Addition of a small amount of aluminum or silicon to the yellow brass, however, prevents these reactions in large degree by creating a film over the surface of the alloy. This film is so tenacious that it prevents distillation of the zinc from the brass, at the ordinary pouring temperature, with the result the alloy pours quietly and in a manner similar to other foundry metals. Aluminum is the metal generally added to produce this quieting effect on yellow brass, but the amount so added must be small, and usually one ounce aluminum to each hundred pounds of brass is enough. To use more than necessary is unwise as it produces dross formation within the mold and causes the brass to shrink on the heavier sections and to crack in corners.

On the other hand when insufficient aluminum is added, while the smoke will be suppressed to large degree, the castings will present a mottled surface showing red and yellow in spots, the red being the natural color of yellow brass sand-cast surfaces and the yellow the change produced by addition of aluminum. The film created on the surface of brass by a small amount of aluminum introduced into the molten alloy is bright yellow, more especially in the case of the low brass alloys and it is thin. The action of this film might be likened to that of a caterpiller tread as the metal flows over sand surfaces.

Film Acts As Tread

This film is laid down ahead of the main body of metal covering the rough sand like a tread, over which the metal flows easily. This action, as the author sees it, is the explanation of the supposed fluidity conferred on brass by aluminum. Actually the metal appears more viscid, but it flows better because the friction of the sand is greatly lessened. When insufficient aluminum is added to produce a continuous film, no continuous tread is laid, and wherever the breaks occur the nonfilmed metal is seen. Thus the castings appear spotty; a condition that sometimes condemns the castings. It can be remedied by increasing the aluminum content of the brass.

It might be thought that the addition of aluminum as a flux to yellow brass constituted a simple solution of all difficulties incident to casting the alloy in sand molds, but it is not so, for the aluminum introduces other difficulties which in the case of some classes of castings makes its use entirely undesirable. One human objection from the viewpoint of the purchaser of castings is the belief that it *cheapens* the metal. The color of aluminized yellow brass is characteristic, being bright yellow as previously mentioned. This gives it away as the sophisticated purchaser regards this color as an indication the brass has been cheaped with zinc. He states that he is paying for what he calls a *good* brass, of say 26 per cent zinc but instead is being sold one of around 40 per cent zinc. So he feels that he is not getting his money's worth, and frequently he will strenuously object to paying for the brass, except on the high zinc basis.

High Zinc Alloys Cast Easily

When aluminum is used in brass there is no justifiable reason for limiting the content of zinc to under 30 per cent, as the high zinc alloys, when aluminized, cast in sand just as easily, if not more so than the low zinc alloys. In fact they have a richer color. An alloy that finds extensive use in this connection contains 60 per cent copper; 38 per cent zinc, and 2 per cent lead, plus from 1 to 2 ounces of aluminum as a flux. A well known line of brass pipe connections has this composition, but as they are tested under an air pressure of 100 pounds per square inch, equivalent to 600 pounds water pressure, (the relation of penetration between air and water is six to one) it is not possible to rely on aluminum as the flux to confer the fluidity necessary to have the brass fill the molds completely. Otherwise the loss due to leakers would be so great the use of the high zinc yellow brass would not be commercially possible.

At the same time, as there is no way of casting this brass without some way of modifying it so that it will flow freely, a compound flux is used that carries the merest trace of aluminum into the melt, with the result no difficulty is experienced in casting the alloy with a loss no higher than in the case of a red brass. The yellow brass of the above composition

gives castings over 50 per cent stronger than red brass, and so ductile the castings can be hammered together and not show the least crack. Yellow alloys of the high zinc class containing aluminum also are used largely for making plumbers ferrules, because they are cheap and also will flow castings much more easily than red metal. An alloy that has been used for many years for this purpose contains 54.75 per cent copper; 40 per cent zinc; 5 per cent lead, and 0.25 per cent aluminum.

Such an alloy possibly could not be used were it not for aluminum, which it will be noted is used in larger amount than is necessary for ordinary yellow castings. Such castings as ferrules are made quite thin. Therefore, to have them completely run, aluminum is used in excess.

Contains High Zinc

Manganese bronze is nothing more or less than a high zinc, aluminized yellow brass. It should carry a trifle over 40 per cent of zinc when made into castings, for with zinc around 30 per cent the full strength of the alloys are not realized. Such alloys as muntz metal, tobin bronze, aich metal, etc., are all high zinc yellow brasses modified and improved in physical properties by the introduction of impurities such as iron, tin and manganese.

It is remarkable what effect some of these additions will have on a simple mixture of 60 per cent copper and 40 per cent zinc. It is possible to get tensile strengths running all the way from 45,000 to 95,000 pounds per square inch and elongations over 25 per cent for the high strength alloys. To obtain the high tensiles it costs more than to get the moderate tensiles as might be expected. Therefore there would be no economy in using such high tensile alloys where a moderate strength would do just as well. An excellent example of alloys of moderate strength is the following. The brass is made without using what is known as a *hardener* to the composition 60 per cent copper; 39.50 per cent zinc; 0.25 per cent tin, and 0.25 per cent aluminum. The alloy has the appearance of manganese bronze but its tensile strength would not be more than around 55,000 pounds per square inch, which for some purposes is amply sufficient.

Nothing is gained by limiting the zinc in an alloy to which aluminum has been added. It might be supposed that an alloy containing 35 per cent zinc, for instance would be soft and also ductile, but it is not so when the mixture is put together by a simple melting operation. This means, that while it may be possible to make an alloy with only 35 per cent of zinc, and get remarkable physical properties, it is not likely to result from simply melting the copper in the usual manner and then simply adding the zinc in the manner ordinarily carried out in making yellow brass. Usually such alloys are disappointing in both elongation and tensile, as many makers of alloys have found out. It has happened in the past, and probably will happen again that in foundries where manganese bronze, for instance, has been made successfully for years, a time comes when it appears that the company does not know how to make it anymore. The foundry falls down hard each time on elongation. In desperation someone usually begins to experiment with the zinc, being under the impression that by reducing it and correspondingly increasing the copper, the elongation of the alloy will be increased. The result is disappointment piled on disappointment for the experiments result in loss of both tensile and elongation, as those who have tried it have discovered.

When aluminum is going to be added to the brass as a flux for the specific purpose of suppressing the zinc fumes and increasing fluidity, the entire alloy should be changed from one containing probably under 30 per cent of zinc, with some tin and lead, to one containing around 40 per cent of zinc, in which case no tin will be needed. Lead can be added at discretion as in the case of the ferrule alloy. A cheap alloy of this class, and somewhat similar to the ferrule alloy is given by Sperry as containing 55 per cent copper; 41 per cent zinc; 4 per cent lead, and 2 ounces of aluminum as a deoxidizer and liquifier.

This alloy is quite strong, and makes excellent castings. It is a much better alloy than an aluminized low brass stiffened with tin, and while it is quite hard, it machines good. For castings that can be made of a brass fluxed with aluminum, it will give satisfaction. The purchaser gets just what he suspects he is getting when he sees the sheen of the brass to which aluminum has been added, and he can be given the benefit of the cheaper alloy.

However, there are some real objections to the use of aluminum in yellow brass. The tendency to leakage of castings even under the moderate pressures of municipal water systems is increased so greatly that the loss from that source would be ruinous. For yellow brass castings used under pressures of air or water, it is safest to insist on the total absence of aluminum. Not even the merest trace by analysis should be present. Aluminum can of course be removed in the foundry, but if this has to be done, the ingot should be penalized, because it is not as good as clean ingot and the foundry refining operation is not without cost. It might be noted that it is more difficult to remove aluminum from yellow brass than it is from red brass and the operation is attended with greater loss.

Therefore, the founder should sidestep such work whenever possible leaving it to the smelter, whose business is the production of ingots, presumably free of injurious impurities. It might be mentioned in passing that there are a number of different methods of eliminating aluminum from red or yellow brass, the best method be-

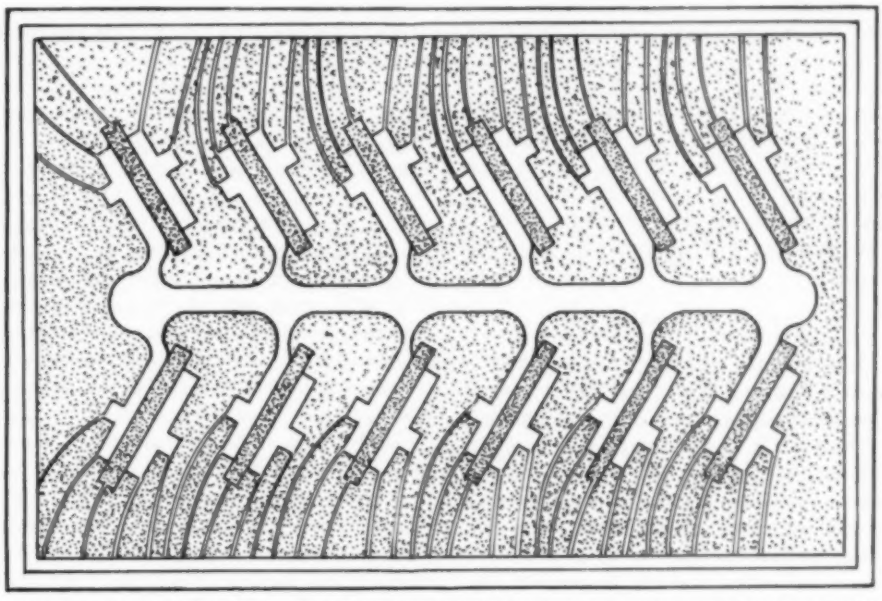


FIG. 2—PLAN OF THE DRAG MOLD READY FOR CLOSING SHOWING THE SMOKE VENTS

ing one of oxidation. The oxidizing agent must hold its oxygen so firmly that the aluminum will be the only element in the melt that is strong enough chemically to wrest the oxygen from the oxidizing agent used, and then only with considerable difficulty. Otherwise other metals in the melt will be oxidized.

Another method claimed to be used to some limited extent employs chlorine instead of oxygen with the idea of forming aluminum chloride which is volatile and would pass away as fumes. As it would not be commercially possible to pass chlorine gas through the molten brass, the chlorine is added as a salt, and cryolite and sal ammoniac have been proposed. Such a method does not appear practical, however. As previously stated the most sensible course to pursue when making yellow brass castings for moderate pressures is to insist on the metal being aluminum free, then add a small amount of phosphorus a few minutes before pouring the castings.

Small Amount Is Best

The amount of phosphorus to add to yellow brass is about half an ounce of phosphor-copper per hundred pounds of brass. It is necessary to avoid using too much, for this is not a case where half an ounce being good, a pound would be better when phosphorizing yellow brass for pressure castings. In cases though, where the zinc content of the yellow metal is around 16 per cent, one ounce of 15 per cent phosphor-copper per hundred pounds of brass can be used with good results. It may be stated therefore, that there are two methods of casting yellow brass (a) when aluminum is added as a flux, and (b) when aluminum is taboo and the brass is used in its normal condition, which also may be termed its raw condition.

When in the latter state as previously mentioned, the pouring of yellow metal is an unpleasant incident of brass foundry practice, due partly to the large amount of fumes it produces when out of the furnace, and the immense amount of gas developed within the molds as they are poured. In the latter case there must be special provision made so the fumes can quickly escape. One method in use for ages consists of making *scratch* vents which simply are shallow channels scratched with the corner of the heel or the point of a stick on the joint of the drag of a mold, reaching from corners of the molded objects to the sides of the flasks as shown in Fig. 2. These permit the zinc smoke to blow out through the joint of the flask, but they are too small for the metal to follow for more than a short distance.

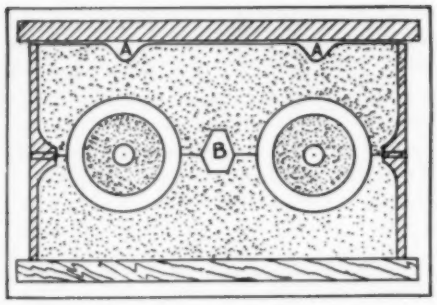


FIG. 3—CROSS SECTION OF MOLD SHOWING VENT CHANNELS A-A; B IS THE RUNNER

Also, when globular bodies are molded, such as the knobs used on brass railings, the cope half of the flask should be channeled over the high part of the bodies as shown in Fig. 3. These are just ditches cut with a gate cutter down the length of the cope and exactly over the highest part of the castings. It is surprising the amount of inflammable gas that will shoot out of the ends of the channels. Metal weights or plates should be put on the copes of molds so vented, boards would be too expensive as they would be burned by the ignited gases from these vent channels. The channels are a great aid in preventing *cold shuts* on the high part of such globular bodies as knobs and globe valves, although the latter are cast in red metal, and not in yellow brass.

Is Easy To Cast

Yellow brass is a troublesome metal to cast and hold pressures even when it contains no aluminum. An ordinary casting yellow metal will contain around 70 per cent copper; 26 per cent zinc; 2 tin, and 2 lead, and this is supposed to be an easy casting alloy. It is comparatively, but in many cases the loss due to leakers, and from other causes incident to its being a yellow brass are so large that the result is a scaling down of the zinc, until in cases by no means exceptional, it gets as low as 16 or 17 per cent. This results in a softer metal, usually it is too soft, and the next move leads to a definite and complete change of composition. In one series of experiments the castings desired in large quantity were in the form of a ring, about 4 inches deep, possibly 5 inches diameter; ¾-inch thick at one end and tapering from the middle to a thickness of ½-inch at the bottom end.

These rings were to be threaded with deep, coarse threads for half their length and the extra thickness allowed for this cutting. Also, they were required to withstand some 300 pounds water pressure, after machining. It was desirable to use as high zinc as possible in the alloy, so an alloy containing approximately 60 per cent copper; 38 per cent zinc and 2 per cent lead plus small amounts of aluminum, for otherwise castings would have been impossible, was tried. It was found that this alloy drossed badly due to the lathering of the aluminized brass, but by elaborate gating methods this largely was overcome and fairly good appearing castings were thus produced at an increased molding cost. However, each and every one failed on the pressure test.

Not Pressure Resisting

Increasing the aluminum helped to get better castings, so it was run up to 2 per cent, but they would not stand pressures. Decreasing the zinc content gave no better results as long as aluminum was used. Therefore, the aluminum was eliminated and the zinc had to be cut to under 30 per cent. In this series an alloy containing 71 per cent copper; 25.50 per cent zinc; 1.50 per cent tin; 1.00 per cent phosphor-tin (5 per cent) and 1.00 per cent lead was reached. Various gating methods were tried with this alloy but trouble due to cold shuts, and veinings of zinc oxide was encountered. In the latter case the smoke would condense on the mold surfaces in an intricate pattern, producing grooves like veins which would not turn out, and the cope side was pitted with zinc oxide. Under the pressure test at least 50 per cent leaked, so for such castings the alloy was impractical.

Ultimately the zinc content was reduced by stages to about 17 per cent. This was too soft, and it became necessary to make a radical change. Something like 3.5 per cent tin was necessary, with 2 per cent lead, and a little nickel and phosphorus. The pouring temperature it was found by experiment had to be near 2000 degrees Fahr. At that temperature there would be few leakers, although the castings were not at all comparable with what would have been obtained with a regular red brass. A tensile strength of around 35,000 pounds per square inch was obtained consistently with high elongation. The castings would weigh about 10 pounds each. The results obtained by all the work confirmed the belief entertained by numerous founders that for castings of such a type a red metal is the safest to use because of the absence of troubles in the foundry.

Variety Is Keynote In Large Midwestern Foundry

Castings Vary in Weight from 2 Ounces to 1 Ton—Part of the Plant Is Devoted to Specialized Hardware and the Rest to General Jobbing Castings

By Edwin Bremer

WHILE the tonnage melted each day in a gray iron foundry gives some conception of the size of the shop, a true perspective cannot be obtained unless some information is given on the type and size of castings produced. The method of molding is another factor to be considered. It is necessary to know whether hand or machine molding is employed and whether the molds are laid on the floors for pouring or are carried by a conveying system to the pouring station. One foundry making large heavy castings may melt 80 tons a day, which is poured into a few castings. Another shop, melting the same amount of metal but pouring it into medium size castings placed on the floor, will have a much greater floor area, while a foundry using a continuous mold and sand handling system may be quite compact.

The greatest discrepancy in visualizing foundry size from the daily tonnage melted appears in the foundry producing a large number of small castings such as hardware, etc. A splendid example of that type of plant is the Chicago Hardware Foundry Co., North Chicago, Ill. That firm makes hardware, cast iron pedestals and backs for restaurant stools, stands for soda fountain drink-mixing devices, frames for radio benches, pedestals and cases for electric hot-air blast, hand-drying apparatus, pressure type and general jobbing castings. The castings produced range from 2 ounces up to 1 ton in weight.

Uses Five Cupolas

To show the variation between tonnage and size due to factors previously mentioned, the Chicago Hardware Foundry Co. employs 5 cupolas to melt a sufficient amount of metal to pour 80 tons of castings a day. Each cupola supplies molten metal for a medium size foundry bay. These cupolas range in inside diameter from 40 to 66 inches, and the iron charges range from 1000 to 2000 pounds. Two of the cupolas, operating alternately, supply molten metal continuously during the day while the other three are operated only during the afternoon.

Silicon in the castings ranges from 2.25 to 3.00 per cent; sulphur from 0.08 to 0.10 per cent; manganese, about 0.60 per cent and phosphorus from 0.20 to 0.50 per cent. The higher percentages of silicon and phosphorus are used in the lighter weight castings. From 5 to 15 per cent steel scrap is used with the harder grades of iron, and 0.25 to 1 per cent nickel and 0.10 to 0.30 per cent chromium additions are employed in making pressure type castings. These additions are made by adding nickel shot and ferrochrom-

FIG. 1—RAW MATERIALS ARE PLACED ON SKIDS WHICH ARE TRANSPORTED TO THE CUPOLA BY GASOLINE DRIVEN LIFT TRUCKS. FIG. 2—CONTINUOUS MOLD AND SAND HANDLING SYSTEM IS USED FOR MAKING PEDESTALS FOR RESTAURANT STOOLS

ium to the ladle. The company also has made some experimental castings of nonmagnetic cast iron. The metal contains about 2.50 per cent silicon, 5 per cent manganese, 15 per cent nickel, 0.20 per cent phosphorus and 0.10 per cent sulphur. As only a few castings were desired, the metal was melted in an oil-fired, crucible furnace. The sand and methods of molding used were the same as that practiced in gray iron founding and no difficulty was encountered in obtaining good, sound castings.

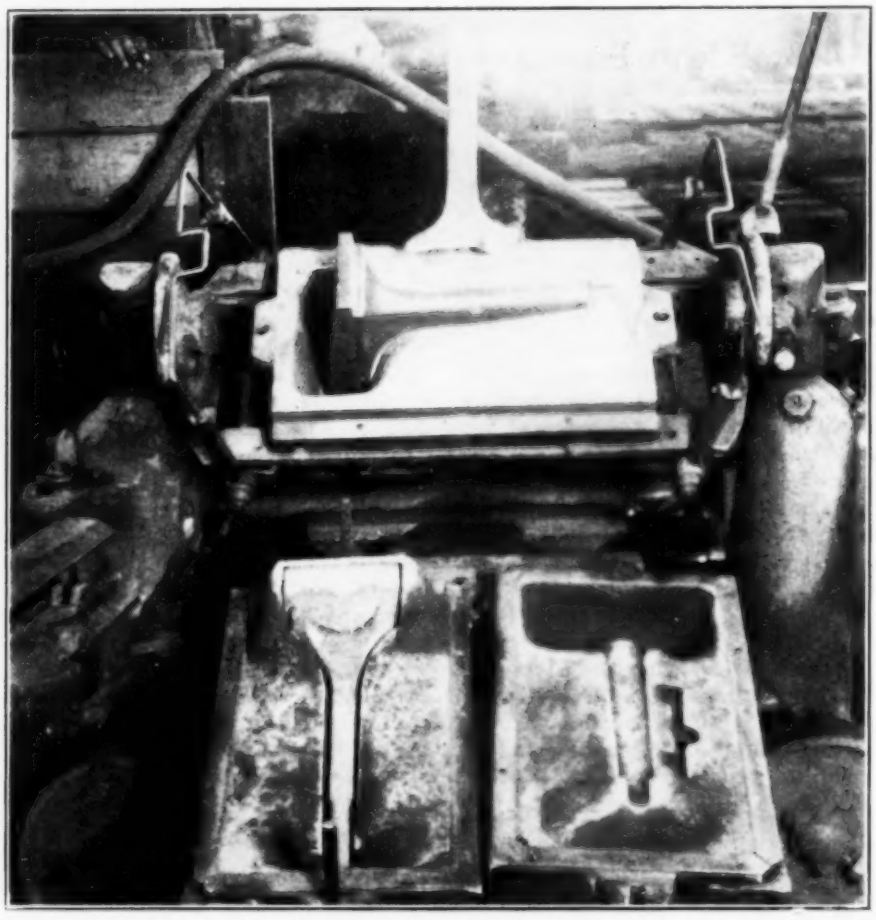


FIG. 3—CASTING, DRAG PATTERN, AND COPE AND DRAG MOLDS WITH CORE FOR MAKING DRINK-MIXER BASES

Molding sand for the various foundry bays is stored in concrete bins with roofs. The sand storage consists of 24 bins, each with a capacity of 120 tons of sand. Core sand also is stored under roof. The core sand bin is located along one side and end of the core room. The bin is constructed of concrete and will hold 600 tons of sand. Since many of the castings made by the firm are enameled, a separate department equipped to carry out this work is maintained.

Raw materials for the cupolas are piled in a long narrow stockyard which parallels the foundry buildings. A wide concrete sidewalk lies between the two and facilitates transportation of materials to the cupola. The method used is shown in Fig. 1, and includes employment of skid platforms and a gasoine lift-type truck manufactured by the Clark Equipment Co., Buchanan, Mich. The skid platforms, which are constructed with angle iron frames and wooden platforms, are transported to the stockyard and a sufficient amount of pig iron and steel scrap for a charge is loaded. Workmen estimate the amount of material to load but due to the experience of the loaders, little change is necessary at the weighing station.

The loaded skid then is carried to the weighing scale where the weight is checked. If the weight is over, pig or steel, as the case may be, is removed until the beam balances. If the weight is under, material is added from small piles near the scale. After weighing the skids are carried to the elevator and raised to the cupola charging platform. A sufficient number of loaded skids are provided on the charging floor to supply raw material for the day's heat. The lift truck also is used for shifting the loaded skids on the charging floor.

Fig. 2 shows a continuous mold handling system installed by the Osborn Mfg. Co., Cleveland. This apparatus is about 35 feet long and 6 feet wide. Heavy cast iron plates connected to an endless chain, and sliding upon two parrallel tracks carry the molds from machine to shakeout. A short section of roller conveyor, to the cast iron plates, attached at right angles to the direction of mold travel, facilitates the placement of molds on the plates and their removal at the shakeout. The machine carries 22 molds which are made on a cope, jolt, squeezer machine and a drag, jolt, rollover machine also made by the Osborn company. Cores in the mold are set by a third man.

Made Two Up

Pedestals for restaurant stools are molded on this machine. They have bases about 8 inches square and are about 26 inches high, curving abruptly at the base and then tapering gradually to the top which is about 1½ inches square. The castings are made two in a flask with the bases of the castings at opposite ends of the flask. The flasks are 14 x 32 inches and were supplied by the Shanafelt Mfg. Co., Canton, O. The drag flask is 6 inches deep and the cope 7 inches. A squeezer board with pads is used to compress the sand between the four bars in the cope. A long runner with gate and riser extends midway between the two impressions in the mold. Four flat branches, two to each impression, feed molten metal to the casting. One branch is attached to the base and the other is attached near the top of the pedestal.

The steel frame elevated above the mold handling system, as shown in the foreground in Fig. 2, pushes the poured molds from the conveyor plates on to the jar shakeout device. The pusher consists of an air cylinder with a fabricated steel arm which makes contact with both flasks and slides them to the shakeout. The jar shakeout consists of a rapidly vibrating grid which is slightly larger than the flasks. After the sand is removed from the flasks, the flasks are placed on roller conveyors which transport them to the molding machines. The castings are placed in big steel boxes on trucks and carried to the cleaning department.

Sand from the flasks drops through the floor into a sand muller where it remains about 5 minutes. During this time enough water is added to bring it to a moisture content of between 6 and 7 per cent. A special device is used to add the water. It consists of a piece of pipe which will hold just enough water to replace that dried out when the casting

is made. This section of pipe has a three-way valve at each end. The handles of the valves are connected by a rod so that they open and close at the same time. The valve at the top has one opening connected to a water line, one to the section of pipe and the remaining one opens to the atmosphere. The valve at the bottom has one opening connected to the pipe, one to the outlet which leads to the sand muller and the third to the atmosphere. The rod connecting the handles of the two valves is arranged so that when the top valve is open to the water line, the bottom valve is open to the atmosphere. This allows the pipe to fill with water. When it is full the handles are moved simultaneously so that an opening at the top connects with the atmosphere and an opening at the bottom allows the water to flow over the sand in the muller.

After the sand is mulled and tempered, it is elevated to an aerator which cools and assists further in conditioning the sand. From the aerator the sand is carried across to the sand storage bins above the two molding machines.

Parting Is Irregular

Fig. 3 shows the molding machine for making the drag; the cope and drag halves of the mold and the core for casting a pedestal. The casting, which is used in a drink-mixing device so familiar in the present soda fountains, also is shown. Drags for this casting are made on a jolt, pattern-draw molding machine supplied by the Osborn Mfg. Co., Cleveland. The copes are made on a plain jolt machine. Taper snap flasks, 11 x 20 inches, 5¼ inches deep for the drag and 5¾ inches deep for the cope, were made by the Arcade Mfg. Co., Freeport, Ill. The parting line is irregular, due to the column of the pedestal being set at an angle to the base. The casting is gated along the side of the column as may be seen on the cope half on the right of the illustration. The sprue enters the center of a short runner which leads to two flat branches that supply molten metal at the top of the column and just above the point where the casting flares out to form the base. An average day's production for this type of casting is 160 molds per day for two men.

Another interesting type of light casting produced by the Chicago Hardware Foundry Co., is a switch frame for automatic telephone systems. This casting is a thin, rectangular shell divided into four parts by vertical and horizontal ribs. It is approximately 2½ x 4 x 5 inches with a metal thickness about ⅛-inch. The drags are made on a jolt, rollover molding machine with a pattern draw supplied by the Osborn Mfg. Co., and the copes are hand rammed on a stripper machine. Four castings are made in a mold. Steel flasks 13 x 16 inches, 3½ inches deep in the drag and 4 inches deep in the cope, and manufactured by the Sterling Wheelbarrow Co., Milwaukee, are used for the molds.

One side of the shell has a small lip projecting at right angles. Since in the method of molding used, the projection is at the bottom of the drag half of the mold, it would be impossible to draw the pattern. Therefore, a core print was made on that side of the pattern, and when the pattern is withdrawn, a small ram-up core is placed in the print. Due to the thin deep section of the casting, sufficient gating is necessary to prevent short run castings. This is provided by gating along two sides of the casting. The sprue is in the center and leads to horizontal and vertical runners extending between the four castings in the mold. Small branches from the runners feed the sides of the casting opposite. An average day's output of this type of casting for two men is 140 molds or 560 castings.

Fig. 4 shows a mold for one of the heavier types of castings made by the company. This casting is an end for a laundry machine and weighs about 600 pounds. As may be observed from a study of the cope and drag molds shown in the illustration, the casting has a large surface area and is light in section. Further, the outer edge of the casting, the circular portion at the top, etc., which are depicted by the raised portion on the cope at the right, form a semi-circular channel which projects above the flat surface of the casting. It also may be noted that a long thin rib runs between the edges of the casting near the bottom, and that the slots in the channel section also will form ribs. The casting is made in wooden flasks in green sand. Rolling over the flask and pattern, drawing the pattern, etc., are done by a jib crane which may be seen to the left in Fig. 4. The casting is gated at one end from a sprue midway between the two sides of the mold. The sprue leads to a runner extending across the end of the mold. Eight branches feed molten metal to the casting. Four risers which may be observed at the four corners of the cope assist in carrying off gases at the beginning of pouring, and collect any dirt that may be washed ahead of the metal.

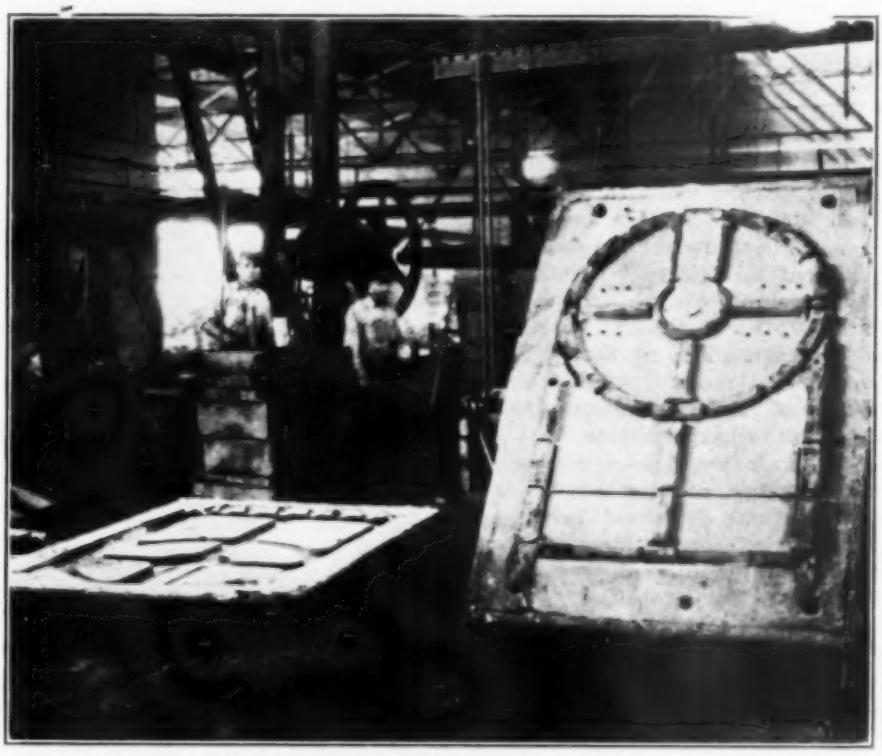


FIG. 4—MOLD FOR LARGE CASTING WITH THIN SECTION. CAREFUL WORK IS NECESSARY TO CARRY THE EXTENSIVE DEEP LIFT IN THE COPE

Warren C. Webb, formerly Chicago sales manager for the W. A. Jones Foundry & Machine Co., 4401 West Roosevelt road, Chicago, has been appointed Pacific coast sales manager for that company with offices at 443 East Third street, Los Angeles.

Use Oxyacetylene to

REMOVE HEADS from Steel Castings

TWENTY-five years have elapsed since the oxyacetylene welding process began to be used commercially. Although this process had been known since 1895, when it was discovered by Le Chatelier, it had remained a laboratory curiosity because of inability to produce oxygen and acetylene commercially in large quantities. Calcium carbide, the material from which acetylene is made, was discovered by Wohler in 1862, but a commercial process was not invented until 1892 when Willson, working on an electric furnace at Spray, N. C., attempted to produce metallic calcium. Instead of calcium, he found that he had made calcium carbide. His discovery made available a method for producing this material commercially.

Oxygen was discovered by Priestly and Scheele, each working independently of the other, in 1774. In May, 1895, the same year that Le Chatelier discovered the intense heat, 6300 degrees Fahr., produced by the combustion of acetylene in oxygen, the first liquid air machine successfully was operated. However, oxygen was not made commercially until 1902. While this progress was being made in perfecting these commercial processes for the production of the required gases, investigators had been working on a device for producing and controlling the oxyacetylene flame. Fouche and Picard devised workable oxyacetylene blowpipes in Paris during 1900-01, and in 1903 the oxyacetylene welding process was used industrially.

Since that time welding has made rapid progress. Hand in hand with oxyacetylene welding went application of these gases to cutting. In 1888 Thomas Fletcher read a paper on cutting; in 1901 a patent was issued to Herman E. Menne for using oxygen for cutting; in 1906 a patent was issued Felix Jottrand, a Belgian, on a device to cut plate, pipe and other metal articles using oxygen and hydrogen, or other combustible gas with a jet of oxygen. It has been claimed that John Harris, Cleveland, cut pieces of steel by this method in 1904.

Fig. 1 (Left)—If Properly Cut, Only a Small Amount of Stock Must Be Removed by Machining. Fig. 2 (Above)—Making the Cut

To the metal industries today welding and cutting are indispensable. This is true especially of the steel foundry industry. Previous to the advent of the oxyacetylene cutting process, the removal of gates and risers was one of the serious problems confronting the steel foundryman. During these times, the heads and gates were sawed off and it was a long process much out of line with present day production methods. The adoption of the oxyacetylene blowpipe for the removal of this excess metal has been a great step forward in steel foundry cleaning room practice. This practice not only has reduced cleaning room costs but also has increased the speed at which castings are passed through the cleaning room. At first only portable outfits were available but as the demand for gas in greater volumes increased and more accessibility to the work became essential, devices were invented to fill these needs. A large amount of credit is due the equipment and supply producers for the advancement of the cutting and welding industry. Many of the devices now in use are the products of investigations and research by the companies which manufacture equipment.

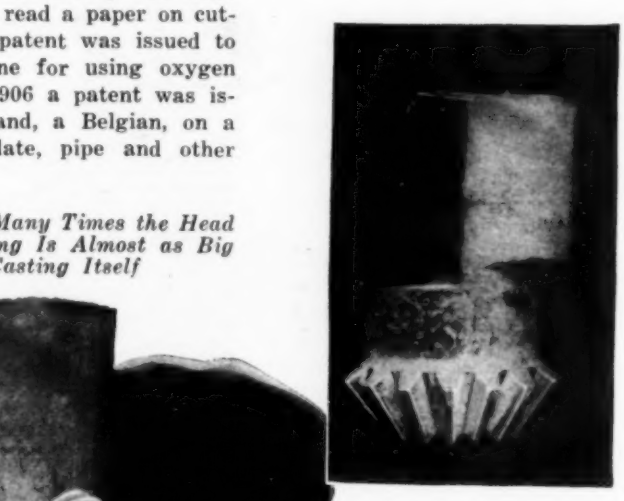


Fig. 3 (Right)—Many Times the Head on a Steel Casting Is Almost as Big as the Casting Itself

Through their publicity departments producers constantly are keeping their customers advised about new developemnts in the cutting and welding field. One of the large producers of oxygen and acetylene is the Linde Air Products Co., 30 East Forty-second street, New York. This company issues a monthly magazine called *Oxy-Acetylene Tips.* An article in a recent issue of this booklet deals with the features of a steel foundry installation equipped for the removal of heads on a production basis.

Oxyacetylene cutting as applied to foundry work, says this article, usually is localized on the cleaning room floor. In many foundries where riser cutting is a production operation, an adequate supply of oxygen and acetylene is piped to various outlets on the cleaning floor. In this way the greatest amount of cutting can be done in one place. All welded pipe lines carry the gases to stations located on the supporting columns on the cleaning floor and in other sections of the foundry. Each oxygen outlet is fitted with a regulator to control the pressure of the oxygen supply and each acetylene outlet has a hydraulic, back-pressure valve.

A cost reducing method which saves time and gases is the segregation of castings. The smaller castings which have the smaller heads and risers should be put in one part of the cleaning room and the castings with the larger heads and risers should be placed in another. In this way, low pressures and small tips are used in one place and high pressure and large tips are used in the other at all times. This eliminates changing tips and gives practically constant pressure at all times.

To eliminate handling large castings the blow-pipe can be connected to the outlets as close as possible to the place where the casting is poured. After the casting has been lifted from the mold, the cutting can be performed while the riser is hot. Often machine cutting equipment is used to make the *kerf* more even and to decrease the amount of machine work.

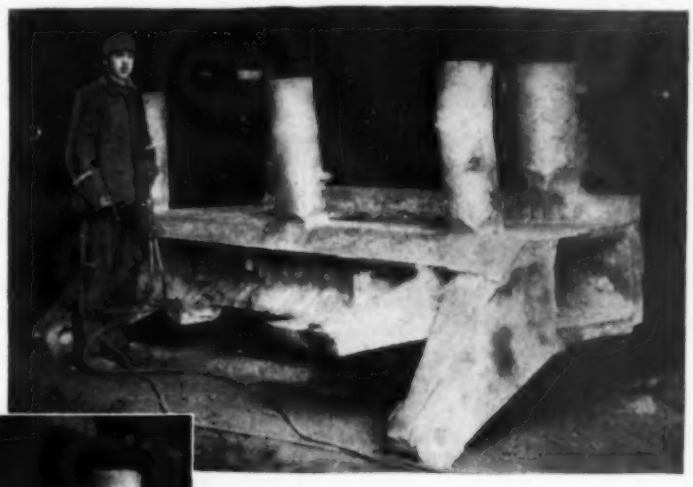


Fig. 4 (Left)—Cutting the Heads Is a Delicate Job. Fig. 7 (Above)—Large Heads Are Cast on Engine Base

Fig. 5 (Right)—Little Machining Is Necessary if the Heads Are Cut Properly. Fig. 6 (Right, Below)—Engine Base with Heads Removed

To use cutting equipment to the best advantage, well trained operators and perfect equipment are necessary. All cutting blowpipes and regulators should be inspected regularly to be certain that they are in the best possible working order. Three stages in the removal of a riser from a pinion gear casting are shown in accompanying illustrations. The neck of this head was oval shaped measuring about 16 inches on its longest dimension and 8 inches on its broadest part. The cut took about 3 minutes. Fig. 3 shows the casting and head. Fig. 2 shows the operator at work. Fig. 1 shows the casting with the head removed. Another set of illustrations shows the successive steps in removing risers from a large engine base casting. Fig. 7 depicts the engine frame and heads. Fig. 4 shows the operator making the cut. Fig. 5 illustrates how an experienced operator makes a cut leaving an extremely small amount of metal to be removed by machining. Fig. 6 shows the heads removed.

Good equipment, experienced operators, segregation of castings as to size and standardization of equipment and methods are principles for the cutting of cleaning room costs.

Questions & Answers on FOUNDRY PRACTICE

GRAY IRON

Makes Fender Dies

QUESTION

We recently have had an inquiry from one of the automobile manufacturers for die castings containing a percentage of nickel. The firm wants us to prepare a metal for them that will give more imprints, have a clean, close grain, and long life.

ANSWER

An alloy cast iron recommended for the manufacture of dies contains 1.45 per cent silicon; 3.00 per cent nickel; 0.90 per cent chromium, and 3.00 per cent total carbon. The low total carbon is obtained by liberal additions of steel scrap.

A mixture to give the above analysis may be made up of 400 pounds of standard malleable pig iron; 400 pounds of steel scrap; 200 pounds of scrap car wheels; 32½ pounds of nickel shot, and 15 pounds of 70 per cent ferrochromium.

Q & A

To Resist Alkalies

QUESTION

Will you please advise us as nearly as possible, the best gray iron mixture to use in retorts for heating sodium bisulphite to 1600 to 1800 degrees Fahr., and holding it at that temperature for some time.

ANSWER

Probably the best material for making the retorts which are to be used at temperatures from 1600 to 1800 degrees Fahr. would be an alloy containing 60 per cent nickel and 12 per cent chromium. This alloy is more corrosion-resistant and heat-resistant than the usual metals used, but unfortunately it would have to be made in an electric furnace to melt this amount of chromium and prevent high losses of this element.

The temperature mentioned, namely 1600 to 1800 degrees Fahr., is above a bright red heat, and not only would the iron be in a condition to absorb or be attacked by oxidizing and reducing gases and chemical salts, but also it would be weak and brittle. Therefore, hardly any metal could be expected to stand up under these conditions for any length of time.

We might suggest that you try a mixture such as used for hardening pots. This contains 0.60 to 1.0 per cent silicon; under 0.10 per cent sulphur; under 0.20 per cent phosphorus, and 0.40 to 0.60 per cent manganese. This cast iron will be on the white side and will last longer than ordinary gray iron under high temperatures. Mixtures of cast iron alloyed with chromium and nickel now are being used to a great extent to withstand corrosive and high temperature conditions.

Chromium may be added in the form of ferrochromium, in the form of chromium bearing pig iron or as a manufactured alloy of nickel and chromium. A method used for cupola additions of ferrochromium, is to imbed the ferrochromium, which is about ¼-inch in size, in portland cement balls. This method is patented. Another method is to put the ferrochromium, ground to 20 mesh, in a paper bag and after the bottom of the ladle is covered with iron throw the bag at the junction of the stream and the iron which is in the ladle.

A mixture using nickel and chromium for the work you have in mind, we suggest should have an analysis as follows: Silicon, 0.90 to 1.20 per cent; sulphur, under 0.10; phosphorus, under 0.20; manganese, 0.30 to 0.50 per cent; chromium, 0.60 to 0.75 per cent; nickel, 1.50 to 2.00 per cent.

Q & A

Average Melting Loss

QUESTION

I should like to know how my melting practice compares with others engaged in the production of agricultural gray iron castings. For example a typical month's report shows a total cupola charge of 1,168,500 pounds, good castings 840,407 pounds, defective castings, gates, miscellaneous scrap 297,095 pounds. The coke charge amounted to 15,697 pounds, a ratio of 7.51 pounds of iron to 1 of coke.

ANSWER

Our first impulse on reading your inquiry is to advise you to keep your fingers crossed. Your luck is too good to last. On a percentage basis your report shows that in a month's run your good castings amount to approximately 72 per cent, gates, scrap and defective castings account for 25.5 per cent, leaving only 2.5 per cent to cover oxidation, melting loss, shot, etc. Theoretically, or possibly in laboratory experiments melting a small quantity of iron, the oxidation and other incidental loss in melting and handling iron might be held down to that figure.

In actual foundry practice where over 20 tons of metal is melted and distributed daily through a foundry engaged in the production of agricultural gray iron castings, the discrepancy between the amount of iron charged into the cupola and that recovered as castings or remelt, usually amounts to approximately 5 per cent. Your coke ratio indicates excellent melting conditions. We always are

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall—Steel Casting
H. A. Schwartz—Malleable Cast Iron
J. W. Bolton—Gray Cast Iron

All questions should be addressed to The Editor, The Foundry, Penton Building, Cleveland.

open to conviction and possibly your figures are correct. However, so many opportunities for discrepancies exist between the stock yard and the superintendent's desk that we hesitate. The actual weight of iron loaded in the barrows, boxes, or pans and charged into the cupola is not always represented accurately on the charge sheets. For example the charge sheet specifies twenty 2000-pound charges. Each of these charges may be from 50 to 100 pounds over weight. They are checked off on the sheet as 2000-pound charges. They are figured as 2000-pound charges in the office. According to the official calculation the total charge amounts to 40,000 pounds. In reality the amount may run from 41,000 to 42,000 pounds, a discrepancy that sometimes is sufficient to wipe out the anticipated melting loss altogether. If you have not actually checked the weights in the charging boxes, we suggest you spend a day in the yard and on the charging deck. You may be surprised to find that the average charging hand's conscience is quite elastic.

GENERAL

Smoke Presents Problem

QUESTION

We have just completed preliminary plans for a new foundry, but there is one feature on which we would like to have further light. Can you tell us what modern foundries where large numbers of cores are used, have done to minimize the smoke nuisance?

ANSWER

Construction of the building, particularly roof design which creates a natural and continuous upward draft is the most satisfactory method yet developed to cope with this annoying feature in the daily operation of a foundry. The ideal foundry in which the smoke is eliminated altogether probably will not come until the millenium. The problem has been attacked from a different angle in several of the big automobile shops where the molds are poured while traveling along on a conveyor. That part of the conveyor beyond the pouring station is covered with a sheet iron hood and the smoke and gas is drawn from this tunnel by a powerful exhaust fan which discharges it outside the building. Details of the exhaust system vary. For example in another installation the poured molds pass under a hood and over a grating. The smoke is drawn down through the grating and afterward discharged through a suitable opening outside the building. In a prominent brass foundry fresh air is sucked through shielded intakes outside the building, conveyed through tunnels under the floor and discharged upward through gratings in the gangways. The purpose of this gentle and constantly moving current is to carry smoke and gas from the molds and furnaces upward toward suitable openings in the roof.

Q & A

Fine Sand Is Needed

QUESTION

We are making a set of cast iron stove patterns from the original wood master pattern and we find that the surface is not as smooth as we should like. What kind of sand should we use to make these patterns. Also what is the most suitable analysis of the iron?

ANSWER

From your geographical location we assume you are using Albany molding sand. If you are not using it, you easily may obtain a supply in which to make your patterns and afterward make the castings. The grade known as No. 0 is used universally in stove plate foundries. This sand is fine but open and imparts a smooth skin to the casting. For patterns and also for castings on which the skin has to be exceptionally smooth, it is customary to pass some of this sand through a small mill where it is reduced to a powder. This powder is dusted on to the face of the pattern to serve as a facing before the pattern is covered with sand. In some instances it is dusted on the face of the mold after the pattern has been removed. The pattern then is returned to place and rapped down. Blacking deposited on the face of the mold from a bag serves the same purpose. The process is known in the foundry as *printing* or *stamping back*. A nice soft iron suitable for stove plate patterns will approximate the following analysis: Silicon 2.75 per cent, sulphur 0.08 per cent, phosphorus 0.70 per cent, manganese 0.50 per cent.

Q & A

Use Roller Bearings

QUESTION

We intend to build a couple of new core oven cars. Is it customary to use ball bearings or roller bearings on cars of this kind?

ANSWER

Roller bearings are employed extensively on the wheels of core oven cars. The diameter of the rollers and the length will vary with the size of the car and the average weight of the load. In a typical example, a car 6 x 12 feet usually loaded with approximately 15 tons of flasks and sand, the rollers on the four wheels are made from ⅝-inch stock 6 inches in length. The outer end of the journal box is provided with a removable cover, also with a hole in the center through which oil may be introduced. A hard alloy steel is the most suitable for the purpose, but ordinary carbon steel bars cut to length and with the ends slightly chamfered give fairly satisfactory service in a number of home made installations. Extremely high temperature to which the cars are subjected is a feature against which no style of bearing is proof. The best that can be done is to oil the bearings while they are cold before they go into the oven. The cars are pulled out hot and dry. Several foundrymen have dispensed with the usual type of wheeled car. They have developed a car that slides back and forth on a number of cast iron balls resting between V-bearings or grooves on the car and similar bearings on the floor. The principal advantage claimed for this type of car is that the weight is distributed over two long lines of ball bearings instead of being supported on four wheels. Before actually committing yourself to the construction of the cars we suggest you get in touch with foundry equipment manufacturers who supply devices of this kind. Through long years of experience they are prepared to furnish a satisfactory article at a reasonable price. If you are not familiar with these people and their product you may find their address and description in the advertising pages of THE FOUNDRY.

Q & A

Making Small Castings

QUESTION

Owing to certain conditions I have decided to discontinue the foundry business which I have been conducting in this little town. Occasionally I may find it convenient to produce a few small castings ranging in weight between 10 and 100 pounds. What equipment is required for this purpose. There is neither gas nor electricty in this town.

ANSWER

You do not state whether or not you retained any of the equipment you had while you were operating the foundry. If this equipment still is available you can utilize it at any time. On the supposition that you have disposed of everything and require to secure the minimum amount of equipment and supplies for the production of occasional gray iron castings we submit the following list: One cupola complete with blower and motor, one shovel, one rammer, several small flasks, one No. 4 and one No. 8 riddle, one set of molder's tools,

about 1 ton molding sand, some core sand with flour or other binder, blacking which may be optional in an emergency, coke for the cupola. Many other things might be included to advantage, but the list given represents the actual essentials.

With no electric current available the ordinary fan motor is useless. You will have to exercise your ingenuity in connecting the fan with some other form of applied energy. For example a windmill, a gasoline motor, a steam engine or a line shaft in some industrial establishment. A small cupola easily can be improvised from a couple of empty oil drums set one on top of the other and with the heads knocked out. Tuyere holes and a tap hole are cut near the bottom and the interior is lined with a single thickness of firebrick. Coke and iron are broken small and charged in the proportion of about 50 pounds of iron to 10 pounds of coke on an original coke bed extending about 3 feet above the tuyeres. If compressed air is available, a branch pipe may be introduced into the tuyeres instead of the regular pipe from the fan.

MALLEABLE

Uses Oil Furnace

QUESTION

Would it be possible for us to make malleable cast iron in an oil-fired, noncrucible, tilting furnace such as used for melting brass?

ANSWER

Malleable cast iron has been produced from this type of furnace in 500 to 1000 pound lots. Materials used for producing the white iron consisted of regular malleable pig iron broken in small pieces, steel (not over 5 per cent), malleable scrap, ferrosilicon and ferromanganese. Losses in this type of furnace will be around 0.40 per cent carbon, 0.30 per cent silicon, and 0.20 per cent manganese. As oxidizing conditions rapidly increase as the metal is heated, small samples should be taken at frequent intervals to catch it at the right point. Ordinarily the melting time will be under two hours.

The samples taken may be poured in an impression made by a shovel handle in the sand. After cooling to below a red temperature, the specimens are water quenched. When the fracture shows an almost white structure with slight graphite precipitation, the metal should be poured. In ordinary malleable practice a sample fracture showing this appearance would indicate high carbon and silicon. However, in the oil furnace this structure will give a heat analysis of about 0.90 per cent silicon, 2.50 per cent carbon and 0.36 per cent manganese if the losses mentioned previously are provided for in the mixture charged.

The white iron may be annealed in pots filled with inert material such as slag, gravel, etc., in an oil-fired oven which has a capacity of about 5000 pounds. Heat rapidly to 1600 degrees Fahr., and hold at this temperature for 48 hours. Then allow the oven to cool slowly at the rate of about 10 degrees per hour to below 1300 degrees. The cooling may proceed rapidly and the pots removed from the furnace when cool enough to handle.

The production of malleable in such small lots will at best be expensive and the control of quality poor.

Q & A

Reactions in Melting

QUESTION

Can you give me any information on what occurs during the melting of a heat of malleable cast iron in an air furnace?

ANSWER

The air furnace is that type of furnace known as an acid furnace, and the atmosphere is oxidizing. By this it is not meant that anything beyond traces of O is present but that the ratio of CO_2 to CO is such that C, Si, Fe, and Mn can still be oxidized with accompanying reductions of CO_2 to CO. The carbon is eliminated mainly as carbon monoxide. However, the sulphur and phosphorus are not oxidized at all and are retained in the metal with negligible increase in phosphorus. Sulphur may increase considerably if a high sulphur fuel is used. The silicon and manganese in part are oxidized to silica and manganous oxide respectively while unavoidably some of the iron is being oxidized at the same time. This results in that a double silicate of iron and manganese is formed. If the lining and bottom of the furnace were inert and no dirt or sand accompanied the charge, this would constitute the slag. As there is more or less erosion of side walls and bottom and siliceous matter is introduced with the charge, the slag consists of mixed silicates of iron, manganese, alumina, lime, magnesia, etc., in which the silicates of iron predominate. In a normal heat the elimination of that part of the silicon, manganese and carbon which is lost, takes place mostly while the charge is melting, and in the absence of small or thin scrap will amount to about 28 per cent of the silicon, from 15 to 20 per cent of the carbon, and from 40 to 50 per cent of the manganese. All these figures are based on the original content.

STEEL

Castings Fail on Job

QUESTION

We are making some cast-steel, water-cooled, electrode glands for an electric carbide furnace in our vicinity, but the glands do not last any length of time. The engineer of the carbide company suggests that the failure (breakage) is due to a magnetic effect which creates a crystalline structure. He also states that the firm is thinking of having the castings made in tobin or aluminum bronze to test his theory of magnetic fatigue. He also thinks he would like to try manganese steel which he understands is nonmagnetic, but has been told that it will not withstand the high temperatures encountered.

ANSWER

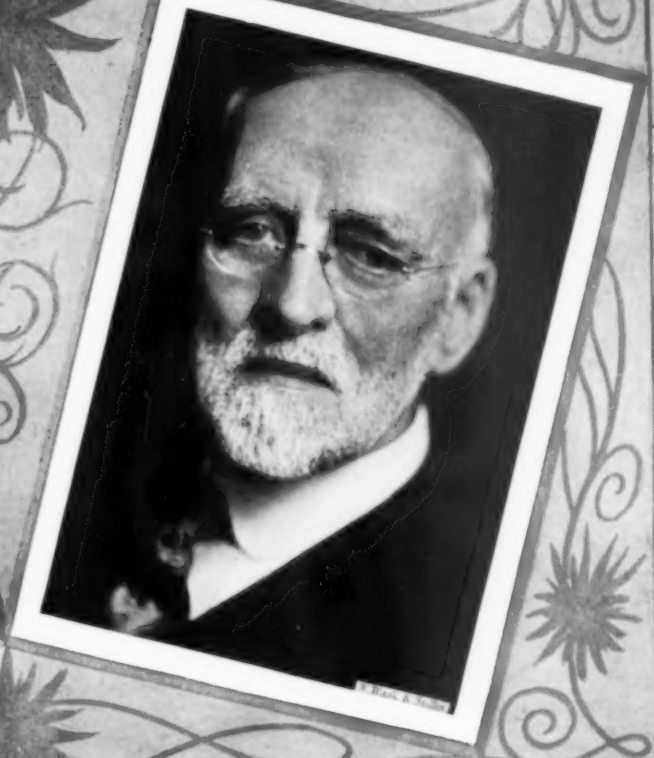
Your inquiry is not an easy matter to answer because information as to the exact type of failure of the castings is not given. We believe that the casting fails through some other reason than that of improper mixture. It may be due to molding, in that if the cores are not held in place by chaplets, they will shift and allow the core to become displaced. This will give a thin and heavy section to the metal instead of an even thickness and will tend to cause cracking of the casting due to internal strains. Another cause of failure may be due to water stoppage which will allow the casting to become overheated and also create an intense pressure due to the steam.

The theory of magnetic ageing is new to us, but we cannot say that such is impossible. Water-cooled rings are used on electrodes of arc furnaces which carry heavy electric currents, and the failure of these castings generally is due to oxidation and scaling from the intense heat. We do not know how long they last, but believe that they last a reasonable length of time.

Our advice is that you examine the castings, at the place of failure.

High manganese steel is nonmagnetic, and is a poor conductor of heat which would make it unsuitable for the application in question. As 12 per cent manganese steel is made brittle by heating it to any temperature above 450 degrees Cent., it probably would crack. However, its application is more along resisting impact abrasion. Chromium is used to make heat resisting castings and runs in the neighborhood of 20 per cent. Tobin or aluminum bronze castings hardly could be used if steel fails to withstand the temperature as they melt at lower temperatures.

The FOUNDRY Family Photograph Album



Upper Left

W. C. ALLEN

Yale & Towne Mfg. Co., New York

Lower Left

H. Y. CARSON

National Cast Iron Pipe Co., Birmingham, Ala.

Upper Right

HENRY SIMS

Sims Co., Erie, Pa.

Lower Right

C. P. CHAMPLIN

Strong Steel Foundry Co., Buffalo

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

ALUMINUM BRONZE DATA

(*Continued from Data Sheet No.* 777)

leased from the heated sand. Many excellent castings are produced in green sand molds, more particularly when the molds are skin-dried thoroughly before pouring. For the finest work it is always safest to use dry-sand, to avoid the possibility of much careful melting and handling being counteracted by moisture in the mold.

For this same reason, to insure metal lying quiet and undisturbed during solidification, it is essential to pay close attention to the venting of cores and otherwise confined bodies of sand, so that expanding air is quite free to leave via the vents instead of bubbling through or causing fluttering of the metal during solidification.

It is recommended that when runners are standardized for any par-

Table VII

Average Properties of Rolled Aluminum Bronze

Composition Per Cent Al	Fe	Ni	Tensile Strength lbs. per sq. inch	Yield Point lbs. per sq. inch	Per cent Elongation*	Per cent Reduction of Area	Brinell Hardness Number	Remarks
Electrolytic Copper			32,000	.....	55	75	30	Soft
Electrolytic Copper			57,000	.....	4	5	90	Hard
5	.....	.....	53,000	.....	55	....	60	Soft
5	.....	.....	69,000	.....	12	....	130	Hard
5	.....	.....	100,000	.....	10	....	.....	Very Hard
7.5	3.5	0.5	95,000	50,000	20	23	190	Hard
7.5	3.5	0.5	76,000	35,000	40	45	150	Soft
8	.....	.....	60,000	.....	61	....	72	Soft
8	.....	.....	83,000	.....	20	....	155	Hard
8	.....	.....	130,000	.....	4	....	.....	Very Hard
8	3	.....	82,000	.....	30	....	122	Soft
8	3	.....	110,000	.....	3	....	205	Hard
8	3	.....	125,000	.....	5	....	.....	Very Hard
10	.....	.....	80,000	.....	33	....	101	Soft
10	.....	.....	96,000	55,000	5	10	180	Hard
10	.....	.....	125,000	.....	5	....	.....	Very Hard
10	3	.....	100,000	.....	20	....	120	Soft
10	3	.....	118,000	.....	2	....	183	Hard

*Elongation on 8 inches.
Values obtained only by severely working small sections.
Reproduced from "Technical Information on Aluminum Bronze" by courtesy of the Aluminum Bronze Manufacturers Inst., 810 Eighteenth St., Washington.

ticular job, the runner blocks may with advantage be bonded with sodium silicate and water (water glass), which will neither burn out nor give off gases during pouring.

Keep gases out of melts by low temperature melting and avoidance of stewing, by stirring gently, by the avoidance of splashing or surging at any period between melting and solidification in the mold, and finally, by the use of sands which will not give off steam or expanding gases vigorously during freezing.

(*Continued on Data Sheet No.* 779)

ALUMINUM BRONZE DATA

(*Continued from Data Sheet No.* 774)

Tests on Die-Cast Test Pieces

Table VI

Composition Per Cent Aluminum	Copper	Nickel	Iron	Zinc	Manganese	Casting Temperature °C	Maximum Proof Stress, Tons per sq. in. Round Piece	Maximum Proof Stress, Tons per sq. in. Flat Piece	Maximum load tons per sq. in. Round Piece	Maximum load tons per sq. in. Flat Piece	Elongation % on 2 inches Round Piece	Elongation % on 2 inches Flat Piece	Reduction of Area Round Piece per cent	Brinell Hardness 250-kg. Load. 5-mm. ball.
						"Aluminum-Bronze"								
	90.3	9.7	.....	.....	.....	(1850	10.9	15.1	18.4	27.4	4	6	12	121
						(1260	12.3	12.9	29.9	23.9	14	4	19	131
						(1160	12.5	14.0	26.3	24.2	9	4	19	129
						(1052	12.5	11.4	29.8	22.2	14	4*	15	123
						"Aluminum-Bronze" with about 1.5 per cent Iron								
	90.0	8.6	.....	1.4	.....	(1350	10.5	10.2	27.0	29.0	25	32	42	118
						(1250	11.1	11.4	31.7	30.9	42	44	42	115
						(1160	11.4	10.5	33.2	30.2	44	34	42	111
						(1065	10.4	.....	22.5	.....	13	....	26	112
						"Aluminum-Bronze" with about 2 per cent Iron								
	87.3	10.5	.....	2.2	.....	(1358	13.4	18.1	37.5	29.0	....	5	....	175
						(1256	13.8	17.4	31.8	30.6	8	5	19	180
						(1150	13.0	17.5	35.6	30.2	13	9	23	176
						(1043	12.7	.....	32.1	.....	9	....	19	168
						"Aluminum-Bronze" with about 3 per cent Iron								
						(1358	13.9	20.2	35.8	29.0*	10	1	17	178
	87.0	10.2	.....	2.8	.....	(1242	14.1	20.5	39.4	32.1*	12	2	18	168
						(1164	15.2	20.8	40.9	33.3*	12	1	15	168
						(1050	15.0	.....	37.5	.....	8	....	17	168
						"Aluminum-Bronze" with 2 per cent Lead								
						(1360	11.4	16.2	24.9	24.0	7	2	12	143
	87.8	10.3	(Lead 1.9)	.....	.....	(1248	11.5	15.3	26.3	23.2*	8	2	15	140
						(1146	10.6	13.6	23.9	25.4	8	5	15	137
						(1052	.....	.....	.....	.....	....	....	....	.....
						"Aluminum-Bronze" with Nickel								
						(1325	24.3	†	36.5	22.0*	1	1	5	207
	82.4	10.0	7.6	.....	.....	(1175	22.4	24.8	38.3	37.4	5	2	7	186
						"Aluminum-Bronze" with Iron and Manganese								
	91.7	1.5	1.9	.....	4.8	1240	12.6	11.1	19.3	21.6	26	21	31	.....
	84.0	9.9	3.2	.....	2.9	1180	14.3	15.1	40.2	35.7	10	6	12	.....

*Broke outside gage marks.
†Broke with extensometer still on.
Reproduced by the courtesy of the Institute of Metals from a paper "Die-Casting of Copper Rich Alloys" by Genders, Reader and Foster, Sept. 1928.
Tests refer to bars cut from a standard die-casting designed to reproduce all the troubles associated with the die-casting of high temperature alloys

(*Continued on Data Sheet No.* 778)

Problems in Nonferrous Founding

By Charles Vickers

Alloy for Propellers

I am starting a small brass foundry and among other things expect to make propellers for speed boats, fishing craft, etc. Is manganese bronze the proper metal for this work, and if so, what mixture should be used? I should also like to know if red scrap can be used to advantage in making good bushing stock. Can copper be alloyed with anything to harden it without reducing its heat-conducting properties?

Manganese bronze is used largely for making propellers for boats and ships. Other metals also are used with varying degrees of satisfaction so that it could not be stated that the proper metal is manganese bronze. An alloy of 89.50 per cent copper; 10.00 per cent tin, and 0.5 per cent manganese-copper, containing 30 per cent of manganese, makes a good alloy; one easy to cast and golden in color. To make what is known as Parson's manganese bronze first compound a *rich alloy* as follows: Take 18 pounds of wrought iron, and melt it in a crucible with 4 pounds of 80 per cent ferromanganese. This will require an oil-fired furnace. Put a cover on the crucible. One can be made from the bottom of an old crucible and it should have a hole in the middle so it can be lifted with a hook. Cover the hole with a piece of firebrick when melting. This cover keeps the metal clean and limits oxidation. When molten add 10 pounds of tin gradually. Pour into thin strips. To make the bronze, melt 56 pounds of copper under charcoal or glass, get it hot and dissolve therein 2½ pounds of the hardener, broken into small pieces, so it will dissolve more easily. Add ½ pound of aluminum and stir well, this will assist the hardener to dissolve. Now add gradually 41½ pounds of zinc, stir and get the metal hot, then cool to pouring temperature.

Red brass scrap of unknown composition is used frequently for making bushings. It is better though to know the composition of the alloy that is used, as some alloys are not adapted for bushings. Also the castings can be duplicated when the alloy is known. The best way to harden copper is to melt and add tin in proportion to the degree of hardness required. Phosphorus also will harden it as will a number of other elements. All of them, however, reduce the conductivity of the copper, either for electricity or for heat. Copper also can be hardened by work. A bar can be cast oversize of a pure copper, then by hammering or otherwise working it, the hardness can be increased greatly, and this is practised frequently.

Q & A

Information Lacking

We ask for a little information about making pattern castings. We use Windsor Locks sand but do not skin-dry the molds, also our bronze mixture seems to be off. Any information in regard to sand molding and the alloy to be used will be very much appreciated.

As the details given are so meager it will not be possible to make suggestions as confidently as though we knew more of the facts in the case. It is possible the Windsor Locks sand is being used too damp and that it is being rubbed through the screen on the face of the pattern. This extrudes the sand in worm-like particles which do not amalgamate perfectly when rammed, with the result of making a rough surface. The sand should be dry enough to screen on the face of the pattern and enough facing should be used to give the patterns a complete coating at least 1 inch thick. If the patterns are flat they can be printed back, but if in the round this cannot be done to advantage so it will be well to depend upon finger ramming to get a true impression until the flask is firmly rammed to one inch above the patterns. It is important to get the sand dampened properly and the mold rammed so the grains of the sand of the facing show a firm, smooth surface after the patterns are drawn. Spray the mold gently with molasses water after the patterns are drawn, then flour it using a bag rather close in texture. Blow off the excess flour and repeat the dusting and blowing off, then torch the mold to a toast color. This flouring is for brass, it is not done for the white metals. A pattern bronze should contain enough tin so that it will be stiff and not lose its shape. The following formula fills these requirements: copper, 90 per cent; tin, 6.50 per cent; zinc, 2 per cent, and lead, 1.5 per cent.

Q & A

Has White Color

We are expecting to be called upon to make 4½-inch fire hose couplings in white metal and would appreciate a formula for such a metal. The expanding pressure required is about 160 pounds per square inch, and the fixture has to be strong enough to withstand much rough treatment.

Use the following alloy: 63.00 per cent copper; 18.00 per cent nickel; 10.00 per cent zinc; 5.00 per cent lead; 3.50 per cent tin, and 0.50 per cent iron. This alloy will have a good white color and will withstand the pressure and rough treatment.

Q & A

Increase Copper Content

Could you inform us what alloy of aluminum could be used with satisfaction for making aluminum castings for airplane motor cylinders and heads. We have found the regular No. 12 aluminum alloy unsatisfactory as it gets too hot and the pistons stick in the cylinders.

The No. 12 alloy is greatly improved for high temperature working conditions by simply increasing the copper, and if 12.5 per cent copper had been introduced instead of the historic 8 per cent there would have been no trouble such as was experienced. When the copper is raised to 14 per cent and 1 per cent manganese is added the result is claimed to be a better metal than the alloy containing only 12.5 per cent copper. These two formulas we believe will afford a selection of a metal to suit the present case.

Producing Steel Castings in the Modern Foundry

Part VI

By Charles W. Veach

WHEN the carbon is down to the point desired in the product, the slag is in a nice creamy condition and proper heat condition of both metal and slag is attained, the next step is partially to kill or deoxidize the bath so that no further change will occur in its carbon content during the time preparations are being made to tap the heat. It must be remembered that we are now dealing with metal covered with a slag which is highly oxidizing, and surrounded by and oxidizing atmosphere. Also that under such conditions the metal is attacked readily by any available oxygen. It must be remembered also that some of the surphur which has been eliminated now is retained by the slag, and that all of the phosphorus is held by the slag as calcium phosphate. Furthermore, that the slag thus functions by virtue of its basicity, and this basicity must not be diluted to any appreciable extent by siliceous additions. Otherwise it will not retain the phosphorus in solution, causing rephosphorization of the metal.

May Contain Impurities

During the time the bath has laid under the action of the flame, and subject to the internal reactions which have constantly stirred the metal, we know that so far as is visible the metal is free from solid inclusions as these have floated to the top and become lodged in the slag. However, experience has taught us to expect the metal, even under the most favorable conditions, to retain some of the oxidized substance as finely divided impurities, which remain in the metal because they are too small to rise to the surface. Even though of microscopic proportions, they apparently affect the metal deleteriously when it assumes solid form. It is partly for the removal of these small particles that the additions are made of materials whose only apparent result is to deoxidize the metal and quiet the action of the bath.

For the double purpose of deoxidizing and to render the products of the oxidation in such form that they will meet and coalesce, spiegeleisen is effective. If it is found that the silicon contained in the spiegel is not sufficient to form enough acid element to react with the basic product, small amounts of high-silicon pig may be added prior to making the spiegel addition. A few steel foundries use high-silicon pig alone to kill the metal, others use 80 per cent ferromanganese for the purpose. The former is only to protect the metal and hold the carbon constant while preparations are being made to tap out the heat. The latter answers the same purpose but enough of the ferro usually is added so that little manganese is added in the ladle. Of the two methods the author prefers the 80 per cent ferromanganese.

Refines the Heat

AFTER the heat is melted, the metal and slag conditions must be observed carefully so that the refining may be carried out rapidly without undue exposure of the metal to the flame. The author describes the addition of spiegeleisen and ferrosilicon and their action on the bath. He also describes practice in vogue 20 years ago in operating a furnace, and compares it with modern operation.

Use of Spiegeleisen

The author has used spiegel for preliminary deoxidation of the bath for several years and is prejudiced in its favor. It is his belief that spiegel when added to the bath 12 to 15 minutes before tapping gives a finished to the metal which nothing else will give. However, spiegel or any other product should never be looked on as a cure-all. It is a rectifier of course, but it is used to further purify steel which has received the utmost of attention from the start to the finish. Its use is merely a step in attaining a product of quality.

Manganese of the spiegel reacts with any iron oxide that may be in the bath, and it is generally supposed that any oxide present at this stage of the heat is ferrous oxide. Being in solution with the metal the oxide is attacked readily by the manganese which is alloyed with the metal. Products of the reaction between the manganese and iron oxide are manganese oxide and iron. The latter becomes a part of the metal bath with all its qualities, while the former floats to the surface where it is held by the slag as long as the latter is in a highly oxidized state—that is, contains an abundance of iron oxide. However, a portion of the manganese oxide is held in suspension within the metal bath because its particles are divided so finely that they cannot rise.

Much Oxide Present

The reaction by which silicon is oxidized during the melting period is as follows:—$Si + 2FeO = SiO_2 + 2Fe$. As there is abundant iron oxide present at this stage of the heat, the silica being a strong acid, attacks the basic iron oxide forming ferrous silicate. Whether a trisilicate or a bisilicate is formed is immaterial. The important thing is that in addition to the iron oxide which the silicon reduced, the silica thus formed removes other iron oxide from the bath and deposits it at the surface where it is out of direct contact with the metal until some time later. This may be verified by analysis of the first slag which is largely iron oxide and ferrous silicate.

When silicon is added to a bath of metal which is already well deoxidized, it may be seen that the residue from

any action between the silicon and iron oxide must be small. Since there is nothing present with which it may unite to form larger agglomerates, it remains suspended in the bath, rising to the surface only with difficulty, if at all. Adding spiegel at the same time or soon after the silicon is added both deoxides the bath and furnishes manganese oxide to react with the silica. The manganese silicate formed rises to the surface.

However, the primary object in adding spiegel is to protect the metal from the oxidizing influence of the slag and furnace atmosphere, thereby preventing any further loss of carbon. If the heat melts properly and is worked carefully it will not be difficult to hold the carbon to within two or three points of the amount desired. Using 18 pounds of spiegel per net ton of metal charged will boost the carbon in a heat about 2 points, and will increase the residual manganese about 10 points, provided the heat has been worked properly. Moreover, the spiegel *kicks* lime from the bottom and clears up the slag. This function is considered one of the most desirable features of adding spiegel just prior to tapping heats.

By running preliminary manganese tests, and knowing how much the spiegel addition will increase this element, the amount finally added to the ladle may be regulated so that the manganese in the product will not vary more than a few points. This element with carbon determines the extent of the heat treatment required so that the metal will meet physical requirements.

Explains Terms

In the language of the furnace crew a heat melting with a deficiency of carbon (such a heat will always have a deficiency of residual manganese also) is said to be *flat*, a *sticker*, or a *low* melt. When a heat melts above about 1 per cent carbon it is said to be *sky high*. A heat may melt low because of delay in charging, making a repair to the furnace during the course of the heat, or because of an interruption in the fuel supply. More than enough carbon is uncalled for, and shows malpractice in making up the heats. Too much carbon is to be avoided more than a deficiency of carbon. However, both conditions should be avoided.

No manufacturing process is so complex, or difficult of control that it cannot be resolved to routine, and, using an inelegant term already overworked, made foolproof. Unfortunately practice in steelmaking, while admittedly a routine, is not foolproof though fast becoming so. The only way this may be brought about is to give the operators some technical training along with coaching them in the practical details. It may be and is argued that the ordinary furnace helper cannot understand the chemistry of the heat he melts and refines almost unaided when it is explained to him. Be that as it may, it cannot be denied that if a tenth part of the expense his employers lose while he is getting his practical experience were to be expended in giving him an idea of the technical phase of his work it would be returned again many fold in the form of higher efficiency. Every man capable of apprehending the actual status of a heat, merely by observing conditions as they are disclosed by the action of the bath, has the ability to learn and understand the laws which govern the actions.

Describes Old Practice

It is found that only a few cases which might be presented as *over* oxidation have been experienced during recent years. However, an experience the author had a short time ago may illustrate the point nicely. It is more valuable because it is something which may occur in the best managed plant.

Twenty or twenty-two years ago it was a common occurrence to have a heat melt low or *flat*. Not only would the heats often melt flat, but the furnace helpers of that time often would *knock* the heat flat with iron ore, sometimes even before the metal was all in liquid form.

Many times during that period the author—then a second helper—assisted the first helper in taking a test out of the furnace and after quenching it in cold water, breaking it to determine the amount of carbon the metal contained. On countless occasions when the test indicated a surplus of carbon (no consideration whatsoever being given to the status of the bath in respect of the amount of metal yet unmelted, or to the thermal condition) iron ore was added, action in the slag stimulated, and melting which had proceeded slowly before would begin again actively. Alas when finally melting was complete there would not be an *ounce* of carbon in the bath.

Now it is evident that with a heat in this condition the operator would have a job on his hands. If he brought it about by an injudicious use of ore as indicated, he should have suffered the consequences—about two hours of work under conditions too severe to be described. Unfortunately not only he himself suffered, but his helpers, his employers, and the latter's customers suffered also. The first by being compelled to do useless drudgery, the second by having to bear unnecessary production cost, and the third by receiving a product far below par.

Furnaces were small, and the bath was shallow. The limestone charge was heavy, and the method of charging put about 30 per cent of the steel charge under the limestone, thus rendering this portion of the charge difficult to melt. The limestone lay so high in the charge, and the bath being shallow, long before the metal was near liquid form the surface of the bath would be covered with lime. Due to low silicon and low manganese in the metallic charge, but due to a greater extent to the nature of the flame, which in this case was developed by the combustion of natural gas, the elements on which we depend to flux the lime were conspicuously absent. Consequently, the lime was always so viscous and inactive that it not only furnished a seal between the flame and the metal but actually became so white and transparent that the heat of the flame was radiated directly against the roof and walls of the furnace.

Furnace roofs and side walls were gutted in short order, and in their endeavor to evade the strain of operating a furnace under a condition which would cause damage to be done to the structure before their eyes, the men used the only material which would stir up the lime and develop a sufficient amount of liquid slag so that it would not radiate the heat to the roof, but would transmit it to the metal.

Methods Were Crude

Whatever the cause of an over-oxidized condition 20 or even 15 years ago the methods followed to correct the condition were crude. It was what was called the *pigging up* process, and as in foundry work the material had to be added by hand, and a few pieces at a time, the work was toilsome and hot. Looking back it may be seen how ineffective the efforts were.

For example a heat will be taken which the helper has *knocked flat* by using iron ore too freely before melting was complete. It can be seen readily that when such a heat is at last all in the liquid state the only action going on within the bath is endothermic, extracting heat from the metal in addition to making the metal so *dead* that the currents by which heat is transferred from the flame

to the metal are inoperative. It was the total inability of actionless metal to extract heat energy from the flame that led steel makers of early times to revert to the use of pig iron to promote a stirring action in the bath.

The stirring action set up by the pig restored in part the currents by which some heat from the flame would be carried down to the metal. That this was relatively ineffective is shown by the great number of times the additions were repeated before the metal finally picked up sufficient temperature to warrant tapping the heat. Furthermore, only in rare cases could any gain in carbon be made, for in most cases the carbon almost all left the heat and was restored by using coal dust or coke dust in the ladle as the metal ran from the furnace.

Work Was Hot

The author has on several occasions added 10,000 pounds of pig iron extra to restore the life in heats which were only 20 tons at the start. The additions were made three pieces of pig iron to the door, or nine in all, and as each piece averaged about 50 pounds it required 22 rounds before the job was done. Furthermore, the iron was not thrown into the bath cold—as would be done today—but was placed on the breast and allowed to get white hot, then was shoved down into the bath with a steel bar. The radiant heat was such at the front of the furnace that the helpers had to wear a woolen cloth sewed to their glasses to prevent their faces being burned. How much easier it would have been to load a thousand pounds of spiegeleisen and a few pieces of high silicon pig in a charging pan and dump it into the bath with the charging machine.

The pig iron was added for the carbon, silicon, and manganese contained in it. These are the elements required to deoxidize the metal, give the stirring action necessary for heating the bath, and the last two confer some heat to the bath directly for the action by which they are oxidized is exothermic. Even with an extreme case using 5 tons of extra pig iron only 350 pounds of carbon would be added, and only about 100 pounds of silicon would find its way into the bath with this much pig iron, while the manganese would amount to not much more than 150 pounds. The phosphorus contained in the iron would confer heat and fluidity as far as it goes, but there is such a small amount that its effect hardly would be noticeable.

If the several amounts of carbon, silicon, and manganese as given above could be added to a bath of 20 tons, no matter how dead or flat the metal might be, new life would be injected into the metal provided the elements could be made available to do their work at once and simultaneously. The secret of treating an over oxidized heat successfully is to get the required elements incorporated in the metal as quickly as possible after the condition is discovered. However, as pointed out before, do not make large enough additions at one time to stop all action in the metal for then the flame will not get in its work.

Now let us see how rapidly we put these elements into the bath under the old methods of pigging up. If the author remembers correctly, basic pig iron 20 years ago contained an average of 1.00 per cent silicon, not above 1.50 per cent manganese, and the usual amount of carbon, from 3.50 to 4.00 per cent. As shown we added nine pieces at a time weighing about 50 pounds each—for they were pigs broken in two pieces—and letting them get hot before they were shoved into the bath. Each round then amounted to approximately 450 pounds, and owing to laying the iron on the breast and then shoving it down not more than about seven rounds could be made in an hour. It required about three hours to work the heat, the flame being maintained as full as possible meantime.

Old Practice Unsatisfactory

Each round of iron gave less than 20 pounds of carbon, about 4½ pounds of silicon, and just under 7 pounds of manganese. These facts taken with the fact that furnaces during this early period of the history of the basic open-hearth process worked far less efficiently than do modern furnaces, it is no wonder that the results obtained, viewed from the light of modern practice, were unsatisfactory.

Now having shown how a case of over oxidation was treated in the old days, a case occurring recently will be described. The trouble began when the line supplying water to cool the oil burners which are stationary, failed, causing a delay of an hour after the heat was charged. The metal was white hot but not melted under. Therefore as soon as the flame was shut off the exposed hot metal oxidized at a rapid rate. When the flame was back on extra pig iron was charged to the limit of the heat but the amount was not sufficient to take care of all the iron oxide formed while the flame was off, so the heat melted with little carbon and residual manganese. However, apprehending a low melt the operator was requested to draw out a test before melting was complete, so that the amount of carbon could be determined definitely and necessary steps taken to prevent it from getting too low.

Carbon Was Down

When the test was taken the bath was covered with viscous lime, so that no action was evident that would disclose the amount of carbon present, but it was evident that the lime contained an unusual amount of iron oxide, and we knew that as soon as the lime became liquid this oxide would be available to the bath to oxidize the carbon. The test showed only 0.22 per cent carbon, and by the way the metal poured we knew that it was badly oxidized and the carbon would decrease rapidly. We had in our favor a furnace which works sharply, and we knew that if we could eliminate the oxide without spoiling the action of the slag, our immediate step having been to add a few shovelfuls of spar to thin out the slag so the gases would escape evenly and freely, that we would have no great difficulty in getting the metal hot enough to pour.

By the time 1000 pounds of spiegeleisen was loaded in a charging pan, the turbulence in the bath caused by metal boiling on lime had ceased. The slag now had thinned out sufficiently to permit dumping the spiegel in the bath without any of the small pieces becoming lodged in viscous lime, and no time was lost in getting this addition made. In the meantime the helpers had thrown in by hand about 150 pounds of high silicon pig. This was added for the heat value of the silicon reaction as well as its effect in clearing up the slag.

After about 15 minutes another round of high silicon pig was added, and the effect 150 pounds of this metal has on a bath of 32 tons is surprising. A test taken after the last addition had worked through showed a tremendous gain in temperature, and showed also that the metal was deoxidized pretty thoroughly. The spiegel had now gotten in its work.

After the silicon had been in long enough so that it did not show in the liquid metal, a test was poured and broken after quenching in water. This test showed a gain of 2 points of carbon and a gain of 12 points of manganese. The slag was in such condition that we knew it would not give up any appreciable amount of iron oxide to the metal during the

(*Concluded on Page* 721)

Bill Offers Advice on Steel Castings

By Pat Dwyer

THE other night while sitting peacefully on the veranda engaged in my favorite occupation of doing nothing, either mental or physical, my idle glance happened to fall on a small volume of essays written many years ago by an able and—I am sure—an exceedingly likeable old gentleman, Ralph Waldo Emerson.

Association of ideas led me to compare my present condition with the theme of his essay on compensation. Everything in the world is ruled by the law of a just balance. A loss in one point is a gain in another and *vice versa*. Nature cannot be cheated. All that a man gets he must pay for, and all that he really pays for he gets.

A more homely and perhaps familiar summing up of this subject is found in the Italian fruit peddler's "What I losea ona de peanut, I makea up ona de banan'."

For the past several weeks the chatelaine of the old homestead and a few assorted members of the family have been touring the country and sending me an occasional postcard with the inspiring message "We passed through here today. Having a swell time. More later." More later usually meant the funds were running low owing to unforeseen contingencies.

To a man accustomed to an efficiently managed and smoothly running household, my present condition was deplorable. I was loaded down to the Plimsol mark with cares and responsibilities. Despite my most earnest effort, the family cat gradually lost his sleek plumpness and began to assume a lean and hungry look. The old friendly camaraderie was missing. He sneaked around in a disgustingly furtive manner, glancing askance at the empty ice box and in a hundred other unmistakable ways plainly showing me that if I was a boon to the family, I was nothing but a baboon to him. Although I had promised faithfully to water the plants regularly and although I had received several admonitory messages in the shape of hastily scrawled postscripts "I hope you have not forgotten to water my plants"—*my* plants, mind you—still, dash it all, a man can't be expected to keep his mind on a set of silly plants day and night.

When I gave them their last drink a few days ago—well, maybe it was before that—I know it was near the end of the week, anyway—I noted a singular lack of vigor. I am debating now whether to install an automatic sprinkler system, or, chuck out the whole collection and buy and install a new set on the day before the prodigals are due to return. One of these days—if I can find the time—I shall visit a place where they sell the things, and get quotations.

While I am on the job, I must try to pick up a spare gold fish, one with a good rough hide. In some unaccountable manner, one of the tribe disappeared last night. If I had left them alone nothing would have happened, but my slavish devotion to duty led me to carry out a final instruction to change the water on the little slippery brutes. Personally, I am in favor of dumping them in the lake where they can make their own changes, but as I said, duty is duty and I am not the man to go back on a promise, or even a half promise. In future I shall make no rash promises.

Unfortunately, I never had been present at an operation of this kind and therefore, had no precedent to guide me. However, on mature consideration I reflected this was an asset rather than a liability. I was not to be hampered by tradition or moss-covered custom. I could approach the problem with a free and open mind and thus develop an ideal method that would involve a minimum amount of time and physical effort. Manifestly, as in any other job, several methods must be available and I knew I should feel deeply chagrined if I hastily adopted one method and then found out later that a better might have been practiced.

Receipt of a message yesterday (collect) HAVE YOU CHANGED WATER ON GOLDFISH YET—STOP — WIRE — STOP — LOVE, brought the affair to a crisis. I wired a reply immediately: CERTAINLY — STOP — ALL QUIET ALONG THE POTOMAC—STOP—GOLDFISH BRIGHT AND HAPPY — STOP — SNAPPING AT THEIR FOOD — STOP — WILL WRITE LATER. I fully intended to carry out that promise and furnish full detail of how I had performed the operation, but in the light of last night's experience I am minded to postpone the letter for a few days. At least until after I have brought the roster up to the full quota. Impartial consideration of many plans convinced me that the simplest method of changing the water in the bowl, would be to place it—the bowl—in the kitchen sink and allow water from the

JIM BLUDSOE HIMSELF COULD NOT DO ANY BETTER

tap to fall into it. I reasoned quite logically that the force of the falling water would carry it to the bottom of the bowl. Naturally this would raise the vitiated water and cause it to flow over the top.

The plan worked splendidly, but unfortunately while I was lighting my pipe—both hands engaged and my attention temporarily diverted—the ingrates in the bowl floated over the top with the water. Prompt and vigorous action on my part was all that saved them from extinction. I clapped one hand over the drain pipe and allowed the tap to run until the sink was filled to a depth of several inches.

Then I was confronted by a new problem. How to capture the slippery little beasts and transfer them back into the bowl. This experience is responsible for the resolution expressed some time back to pick out a goldfish one of these days with a hide like that on a rhinoceros. Something on which the fingers can take a grip without danger of squashing the contents. This was one of the occasions on which I realized to the full the poignant significance of the well known quotation: "It is not good for man to live alone." Hopelessly handicapped by the necessity of keeping one hand over the drain pipe, I wasted half an hour vainly trying to nip the little bounders.

Finally, just as I had decided to remove the perforated disk over the drain pipe and shoot the whole kettle of fish down the sewer, I had a brilliant idea. Even in the privacy of my own kitchen with not a living soul to jeer and point the finger of scorn at me, the hot blush of shame and embarrassment mantled the fair cheek at my stupidity in not thinking of the obvious solution before.

I filled one of the handy milk bottles with water and placed it over the disk and then with both hands free I sighed a healthy sigh of relief and proceeded to put the plan into execution. With a small stillson I unscrewed and removed the trap from the pipe under the sink.

Here I was confronted with an unforeseen contingency. As nearly as I could calculate off hand, the sink contained about 3 gallons of water. The fish globe at the most generous estimate would not hold 2 gallons. If I carried out my original plan and allowed the water and fish to flow down the pipe, the globe would overflow, the floor would be inundated—involving more work—I would get my feet wet and—worst of all—the measly little imps would float out with the overflow as in the first instance. Those cute little wigglers were perilously close to a sudden and violent death at that precise moment.

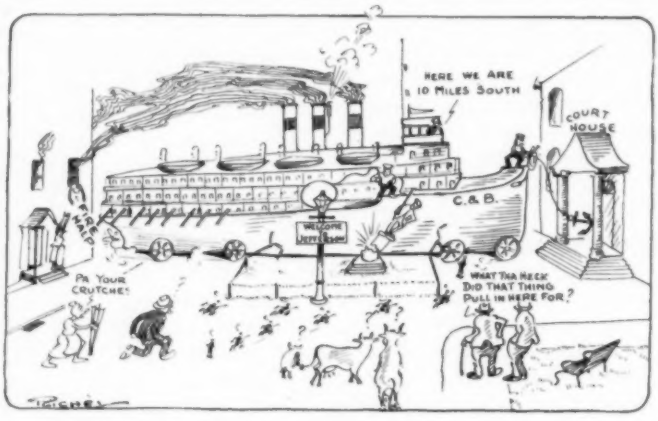
Breathing heavily through my nose, I replaced the trap, cautiously moved the bottle a trifle and allowed the water to escape until only a sufficient amount remained to fill the globe about three parts full. Once more I removed the trap, lifted the bottle and disk and, with the legitimate pride of your true craftsman, watched water and fish vanish down the pipe and reappear in the bowl below. *Labor omnia vincit*, in other words, Hot Dog! The job was done!

A casual examination of the bowl showed that the water was not quite as clear and pellucid as the sparkling rill which flows sweetly over the silver sands in a lush meadow where sleek kine graze knee deep, but, it will have to serve. The value of all the kine that ever grazed between the Canadian border and the Rio Grande would not tempt me to repeat the experiment. Fish are all right in their place, but their place is out in the middle of the lake.

I am still at a loss to account for the disappearance of one little villain, but I am not grieving. As I said some time back I shall pick up one to replace him—or it—one of these days. In fact I may have to replace the whole tribe if the verdigris from the pipe poisons them. Oh! Well. Into the sunshine of every life some rain must fall and if they cannot assimilate a modest amount of verdigris, that's their hard luck. I'm no diet specialist. I shall consider myself lucky if I don't poison myself before the summer is over.

Three loud cheers from the impatient reader who thinks—mistakenly of course—that I have forgotten all about the late Mr. Emerson and his essay on Compensation. The more charitably inclined reader probably clucks his tongue sympathetically and says to himself "That's what comes of living alone. By this time that bird has fallen into the habit of walking along the street making gestures with both hands and talking to himself. Too bad to see a fine intellect (I thank you) going to seed like an overgrown onion plant." Not so good!

Well, I am happy to say you are both wrong. I had the essay in mind all the time. The foregoing incidents merely were presented to illustrate one side of balance to which Mr. Emerson refers. To compensate for the trials and vicissitudes listed—and maybe a few more—I have enjoyed many blessings. No one wakes me in the middle of the night to listen to the rain or the thunder, to ask if I am sure I locked the doors and shut off the lights. My pipe never disappears from the window seat. When I come home at night I don't trip over furniture that shifted its position during the day. If I don't like the radio program, I can shut it off. When the telephone bell rings, I just let it ring. Above all else I can read the paper in peace and comfort, commencing at the front page and reading it through to the last page in proper order, with the sheets folded as they should be folded, in the center. When I sit down to read a paper I want something that looks like a newspaper and not a rumpled collection of junk that appears to have been salvaged from a fence corner after a windy night.



FISHERMEN'S STORIES USUALLY ARE ALL WET

Under the item: *Good and welfare of the order* I asked Bill if he had any suggestion to make that would assist me in solving this perplexing household problem.

"Well" said Bill "I'll tell you. When you come home at night, you can grab the paper with one hand and allow the other hand to rest nonchalantly on the handle of a baseball bat. The moral effect should be sufficient, but in the event any person stretches forth a predatory hand, a vicious gesture with the bat usually will forestall any silly argument.

"If this expedient fails and if you are too tender hearted to follow your implied program by bringing the bat down heavily on encroaching fingers or toes, you might try the alternative of buying a second paper for your own exclusive use. Rank waste and extravagance, I'll admit, but as old what's-'is-name said one time 'Peace

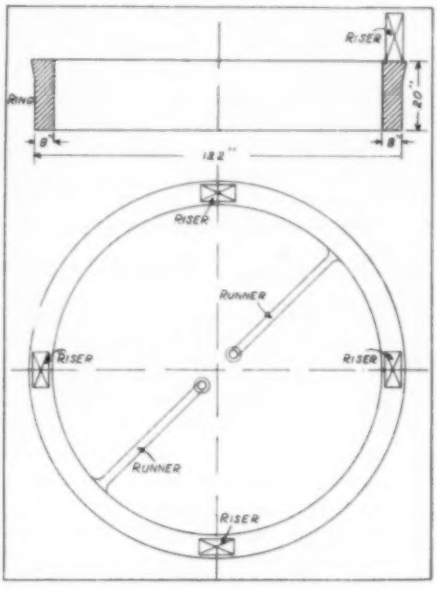
hath her price as well as war.'

"You would not miss much if you quit reading 'em altogether. Do you remember the story that was published a few months ago when the CITY OF BUFFALO suffered an accident and wallowed around in the lake for 24 hours? Her engineers fixed her up and brought her into port safe and sound, but to read the newspaper stories you would think she was battered to a pulp and her passengers and crew were dying of exhaustion, exposure and starvation. One brilliant reporter had her slowly pounding to pieces on a jagged ledge of rock 10 miles *south* of Ashtabula harbor. He must have thought he was talking about an air ship. The CITY OF BUFFALO is a staunch old craft but I doubt if she could make a 10 mile journey inland and come to rest in the public square of Jefferson, O.

"Forget all that tripe for a while and listen to an inquiry I had from a foreign foundryman the other day. It was written in English—good English too, mind you—but one statement leads me to wonder if the writer did not make a slip of the pen.

"He makes steel castings in a wide range of sizes and in weights ranging from ¼-pound to 15 tons. The metal is melted in an open hearth furnace and also in an electric furnace and is poured at an exceedingly high temperature. The small castings are poured from the same ladle as the large castings. Small castings peel fairly well, but castings over 1 inch in thickness and over 40 pounds in weight present a dirty and pitted surface from the sand that is fused to the skin. Even with large sinkheads on the larger castings he finds pipes. For facing he uses what is considered the best material in his country: 50 per cent white silica sand and 50 per cent yellow sand. The first sand shows a silica content of 96 per cent. The yellow sand has a silica content of 82 per cent and carries a natural binder. The molds are washed either with powdered silica rock mixed with molasses water or with a mixture made up of old graphite crucibles ground to a powder 18 parts, ordinary graphite 3 parts also mixed with molasses water. He enclosed a sketch of a 7-ton ring, 10 feet diameter, 20 inches deep and 8 inches thick. Metal was poured into a runner over the center of the mold and was conducted into the mold cavity by two long gates extending from near the center on a diametrical line. Four large risers were spaced equidistantly on the top. The metal remained liquid in the heads for over 2 *hours* and the casting was exceedingly rough on the surface after it was taken from the mold. Steel rolls come out of the molds in the same condition with a coating of sand fused on the surface. For roll facing he uses ground brick and silica quartz with fire clay as a binder. He asked if he was pouring the metal at too high a temperature or is the facing at fault.

"I wrote him that if the translation of the letter is correct in the item which says 8-inch square risers remained liquid for 2 hours I was afraid I was in no position to offer advice of any kind. I never have seen or



PLAN AND SECTION OF LARGE STEEL RING

heard of steel that would remain liquid in a mold of that size for one hour or even for half an hour. I cannot conceive of any mold material that would withstand the temperature of metal of that kind.

"Assuming that the figure is a slip in the translation, it is still apparent that he is pouring his heavy castings at an unnecessarily high temperature. The steel of course must be exceedingly hot for the small castings, but the larger castings should be poured at a much lower temperature. From the statement that he pours large castings including 15-ton rolls I assume that he employs a single large bottom pour ladle. Two courses of action are open. One is to pour all the light castings first, then allow the metal to cool in the ladle and afterward pour the heavy castings. The second method is to pour the small castings from a small ladle and reserve the large ladle for the heavy castings.

"The natural objection to the first method is that practical foundry experience suggests that the heavy castings should be poured first while an ample supply of metal is available. If a small casting is poured short at the close of the heat the loss is not great. Pouring a large casting short or standing by without a reserve supply of metal in the event a large mold develops a leak means a heavy loss. Also, if a surplus of metal is left in the ladle after a heavy casting is poured, it is too cold to be poured into small molds.

"The second is the logical method and is the one practiced almost universally in this country. In bessemer converter and electric furnace foundries the metal is tapped into a teapot ladle of from 1 to 3 tons capacity. Small castings are poured in some instances over the lip and in other cases, the metal is transferred to the ordinary type of double shank ladle handled by two men. In his case he easily could fill a teapot ladle from a large bottom pour ladle and use that metal for the small castings. The amount of metal remaining in the large ladle may be weighed or estimated and allowed to cool to a suitable temperature before it is poured into the large castings.

"According to the silica given, his sand should prove satisfactory for facing sand if the steel does not exceed ordinary casting temperature. In this country we secure satisfactory skin on castings by the use of sand that does not fuse under 1600 degrees Cent. Pulverized silica mixed with molasses water or any other form of diluted core binder is used for a wash for the surface of the molds and cores. In the early days of the steel industry many mixtures were made up including pulverized crucibles as one of the principal ingredients both for facing and for a wash. They are no longer used. The clay in the mixture causes the facing to fuse to the face of the casting. The ideal binder is one that is consumed by the heat and leaves no residue. Spraying the face with alum water imparts a hard surface and helps to secure a clean skin on the casting."

Wants Equipment Prices

The Pacific Trading Co., 13 Peking road, Shanghai, China, is interested in literature and prices on electric furnaces, oil fired cupolas, molding machines and miscellaneous foundry equipment. The company is particularly interested in centrifugal casting machines for pipe.

R. W. Procter, formerly with Black & Decker Mfg. Co., Towson, Md., has been appointed general sales manager of the Van Dorn Electric Tool Co., Cleveland. He succeeds Lyman H. Bellows, who resigned recently.

Many Factors Affect Production of Sound Iron Castings

Proper Design of the Casting, Careful Testing of Materials and Satisfactory Pouring Temperatures Are Important Considerations

Part II

By R. W. Kurtz

MOLD gases consist mostly of dissociated steam which is combustible. If forced into the metal, the free oxygen, which constitutes about one-third of its volume, will attack the metal vigorously. As a result one is apt to find particles of dross or slag in badly blown castings, and the molder will likely take refuge in the good old alibi *dirty* iron.

Blowability values above 10 grams (a little over ½-inch of ferrostatic pressure) are considered dangerous or at least not foolproof at our foundries. Above this value there is a constantly increasing tendency toward scabby surfaces and toward gas pockets, due to the trapping of the primary mold gases or to the secondary oxide reaction which is described in detail later. In actual practice mold gas pressures do not depend solely upon the blowability value of the sand nor do uniform pressures result at all points on the face of the same mold. Other modifying factors are:

Degree of ramming and venting employed in making the mold in question.

Size and shape of the casting.

Temperature and specific heat of the metal.

Temperature and specific heat of the mold.

Blowability value of 10 grams per 100 cubic centimeters stipulated for our sand and is conservative and with favorable modifying circumstances may be exceeded safely. In any case, such possibility is simply a question of whether or not the ferrostatic pressure can be maintained, from the start of the pouring until the metal solidifies, constantly higher than the mold pressure. Probably the most practical way of settling this question is to cut away a portion of the cope of the mold so that the reaction to the hot metal may be observed.

Describes Apparatus

IN THIS article, which is the second of two, the author describes gas defects and enumerates a number of metallurgical defects with data on how they may be avoided. He then describes apparatus used in making tests for a combination permeability and tensile test; a blowability test, and a hardness test. Directions of the methods used in performing the tests also are given. The two articles are abstracted from a paper presented at the Chicago convention of the American Foundrymen's association.

Utmost care and precaution exercised in the making of molds and cores still may fail to prevent the occurrence of gas pockets, especially under the cope surface of large or deep castings. These defects are of metallurgical origin and variously have been attributed to the following general causes:

Liquid shrinkage (outward) in opposition to solid contraction (inward).

Carbon monoxide gas formed by the reaction of carbon with entrained particles of iron oxide.

Sulphur dioxide gas formed by oxidation of manganese sulphide.

Liberation at lower temperatures of gases dissolved by metal at high temperatures.

We never have been able to identify either of the last two causes with defects found in gray iron of usual composition range. Neither have we been able to identify positively the first two causes, which are quite common, with our melting practice. De-

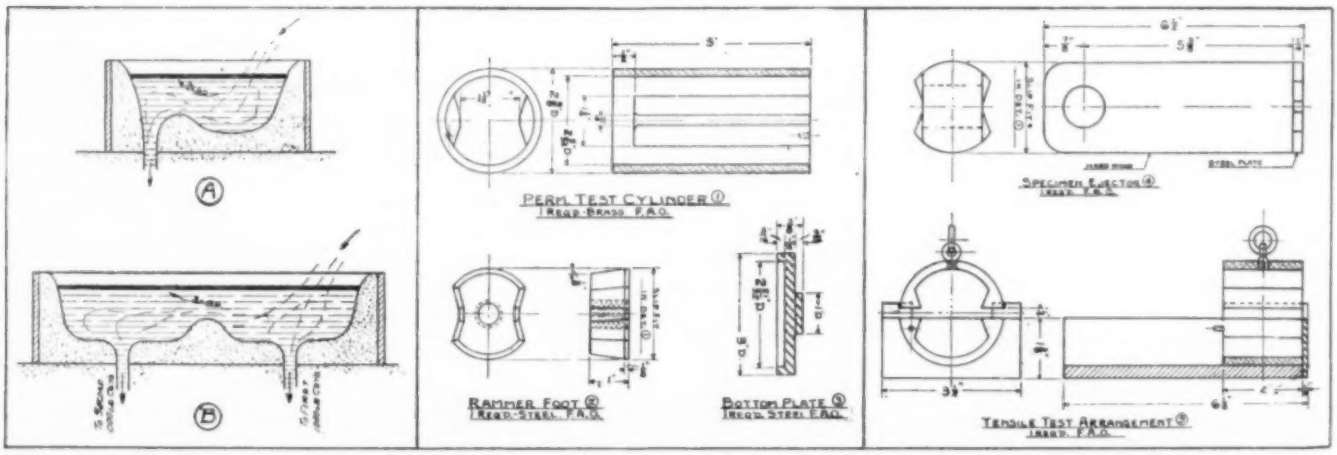


FIG. 5—*A* IS POURING BASIN FOUND SUITABLE FOR CASTINGS INVOLVED WHILE *B* IS A DIRECT TYPE FOR POURING TWO CASTINGS. FIG. 6—DETAILS OF PERMEABILITY-TENSILE TEST CONTAINER. FIG. 7—TENSILE TEST ARRANGEMENT

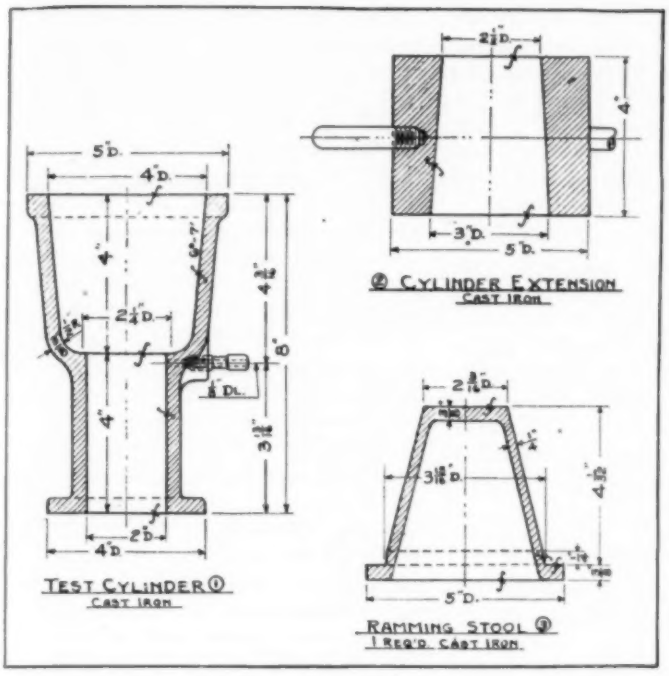


FIG. 8—DIAGRAM OF BLOWABILITY SPECIMEN CONTAINER SHOWING THE VARIOUS DIMENSIONS

fective grain structures which tend to porosity, checking, brittleness, etc., often have been traced to melting practice, but actual blowholes invariably have been found to originate in certain phases of our pouring or molding practice.

We do not mean to say that blowholes in gray iron castings *cannot* originate in the melting practice. In our own case however, we have found none that could not be explained satisfactorily.

Our cupola practice is not unusual in any way. In times past we blamed our cupolas for every conceivable trouble with our castings and endeavored unsucessfully to correct the same with all manner of changes in tuyeres charging, fluxing, etc., Where we corrected our molding and pouring practice, blowholes disappeared and caused no more trouble.

Oxidizes Easily

Whenever red hot or molten iron is exposed to contact with air, whether it be in the cupola, ladle, runner, or mold itself, the surface of the metal quickly oxidizes, i.e., combines with the oxygen of the air into compounds called slags, or *oxides*. Unfortunately, for foundrymen, iron oxide can react with any carbon present to form carbon monoxide gas. Both these reactions may be observed frequently in a waiting ladle of iron—the oxides or slag forming on the exposed top surface and the carbon monoxide bubbling up around the sides of the ladle where old adhering oxides are being reduced by the carbon of the metal.

Unlike oxides formed during the pouring operations, oxides formed during the melting operation have a much greater opportunity to rise, or to be completely reduced while the metal is sufficiently fluid for the gases formed to escape. Good melting practice should be supplemented by still better practice.

Shrinkage cavities generally may be distinguished by their irregular shape sometimes described as pine tree structure. Carbon monoxide blow-holes, however, are not easily distinguished, from mold and core blows. Their identity may be established by systematic elimination of other causes and the diagnosis then be confirmed by intentional production of the defect.

Gives Factors

Same general factors which have proven helpful in avoiding these metallurgical defects follow:

Temperature of metal should just be sufficient to run the casting and generously proportioned gates should be used for this purpose. Excessive temperatures mean excessive liquid shrinkage and often cavities from strained mold sections. The proper pouring temperature depends upon the composition of the metal and the size of the casting. No satisfactory rule covering the universal case has ever been formulated for pouring temperatures and gating. Dietert and others have worked out formulas covering certain types of castings, but an almost infinite number of special cases remain where practical experience and trial must be relied upon.

When heavy and light sections cannot be avoided in a design, large risers may be used to feed up the heavy sections of the castings. Pumping the metal of the riser with a rod is also helpful.

Chills also may be used to expedite the solidification of the heavy sections. Both internal and external types are used with varying degrees of success. Different rates of cooling are obtained with external chills by changing their size and their distance from the surface of the mold.

Prevention of iron oxide formation if practical, would be the most logical method of avoiding oxide inclusions. For this purpose the atmosphere in a mold being poured should be reducing. The lip of the pouring ladle should actually enter the pouring basin so that the metal will be exposed the least possible amount to the air. The surface of the metal in the ladle should be skimmed clean, and then may be covered with blacking, sand, or other protection from oxidation. The sides and bottom of the ladle should be kept as free as possible from oxide incrustations. If oxide inclusions *in* the ladle metal are suspected, additions of deoxidizing alloys should be tried. It is also advisable to melt sufficiently hot so that the metal need not be poured until tramp impurities have had a chance to rise to the surface.

Prevents Formation of Oxides

When iron oxide *is* formed, it sometimes can be prevented from entering the mold. Teapot and bottom-pour ladles are helpful but neither prevents oxides which form in the pouring stream, basin, and mold, from getting into the casting. Skim and strainer gates are moderately successful in that any large foreign particles will be trapped out. A good idea of the efficiency of any particular style of gate may be obtained by making up a model and trying with water covered with ground cork, to represent

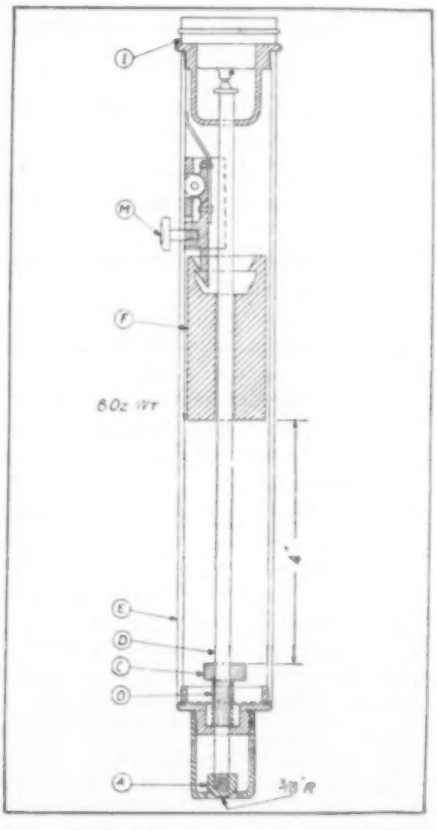


FIG. 9—DIAGRAM OF THE HARDNESS TESTING DEVICE

oxides. It is surprising how the ground cork will slip through almost any type of trap gate, in spite of the greatest care in pouring. The most efficient type we have found is that of *A* in Fig. 5. The principle of this type is to retard the stream of metal as it enters the mold and thus give impurities a brief chance to rise and be retained in the pouring basin. A convincing test was made at one of our foundries to compare this type of gate with the direct type as shown in *B* in Fig. 5. From an accumulated total of 91 castings showing oxide defects, 74 were with direct gating.

If oxide inclusions do enter the mold, there are a few remedies possible. The oxide slags may be skimmed from open sand work. The casting should then be covered to about one inch in depth with sharp sand and some dry blacking, which will prevent pitting effectually. The oxide may sometimes be dissolved by additions of borax to the *molds*. In the case of heavy castings, the oxides may be collected in extension heads which are cut off later. When comparing the merits of castings made with and without extension heads, it always should be remembered that to cut off the evidence of trouble is no assurance that all harm has been corrected, especially in the case of small or light weight castings, which solidify too quickly to permit impurities to rise freely. On the other hand, a sound top or cope produced without an extension head, is an indication of sound metal throughout.

Tells Important Points

The important points, to which are ascribed particular value in the production of sound castings are three in number:

Design to simplify foundry practice as much as possible.

Test molding materials and arrange control methods, especially for the moisture in green sand molds.

Pour at proper temperature and in such a manner that iron oxide particles may not become entrained in the casting.

The special equipment used, combination permeability—tensile test previously mentioned, is shown in Figs. 6 and 7. The only difference between the permeability cylinder of Fig. 6 and the standard A.F.A. cylinder is that the area of the specimen (3.1416 square inches) has been changed in *shape*. The cylinder is filled, rammed and permeability determined in the same manner as with standard cylinder. Values obtained by either, check closely.

The cylinder is next placed in the tensile device guide, from which the specimen is pushed into the pulling jaws. For loading we use a special core testing machine supplied by the Wadsworth Core Machine & Equipment Co., Akron, O., which is arranged with 1 to 2 leverage for weak specimens and 3 to 1 for strong.

This test has the advantage of speed and accuracy combined with easy manipulation and may be used for both green and dried specimens. Dried specimens can be placed in the pulling jaws better if a slight clearance is provided. Very strong materials can be used in half portions, if desired, by using half the standard ramming work and half the permeability value obtained.

Describes Special Equipment

The special equipment used for the blowability test is shown in Fig. 8. The test cylinder first is inverted over the ramming stool and filled with the proper amount of sand for a 2-inch permeability specimen. After the first ramming blow, with the weight resting on the specimen, a 3/32-inch diameter needle is run well into the sand through the small tube in the side of the cylinder. After the final ramming blow, the needle is withdrawn and the permeability of the specimen is measured in the usual manner. If the specimen is to be dried, the permeability is measured after drying. In either case the cylinder should be warm enough to prevent moisture condensation prior to pouring.

The small tube on the side of the cylinder next is connected with a manometer by using a short section of rubber tubing wrapped with a wet rag as a protection from the heat of pouring. The cylinder extension is used if the pressure is likely to be high and the whole poured up as rapidly as possible with iron at 2450 to 2500 degrees Fahr. from a hand ladle.

At the end of about 45 seconds, the pressure indicated by the manometer will have reached a maximum or will be changing slowly. This value is noted and the cylinder dumped out as quickly thereafter as possible. A pair of circular jawed tongs is convenient for this latter purpose.

With a little care values may easily be obtained which do not vary more than 10 per cent from their average. This test is useful in determining the effect of various combinations of moisture or other volatiles and permeability. It also may be extended to investigations with various pouring temperatures such as obtained with brass, aluminum and other metals.

A sectional view of the special device used for the hardness test is shown in Fig. 9. It will be noted that this apparatus consists of a cylindrical weight *F* which is allowed to fall and strike a collar *C* on shaft *D*. At the bottom end of the shaft is a hardened steel speroid *A* which is caused to make an impression in the sand. The depth of this penetration is given directly in thousandths of an inch by an indicator *I* at the top of the shaft *D*. The weight of the shaft itself is taken by the light spring *O* and the whole assembly is encased in the tube *E*.

Operation of the device consists simply in resting the tester in a vertical position on the sample; adjusting the indicator to the zero mark; releasing the weight by pressing the spring-latch button *M*, and observing the reading at *I*. The hardness of the sample is in inverse ratio to this reading. Vertical and inclined mold surfaces must be rotated to a horizontal position to apply this test.

Tests may be made rapidly and we have found the device surprisingly sensitive. As an interesting example; it indicates variations in compactness from 5 to 10 per cent to exist between the top and bottom surfaces of standard permeability specimens.

Book Review

The ABC of Aviation—by Victor W. Page, paper, 143 pages, 5¼ x 7¼ inches, published by the Norman W. Henley Publishing Co., 2 West Forty-fifth street, New York, and supplied by THE FOUNDRY, Cleveland, for $1 plus 15 cents postage. The book may be obtained in London from the Penton Publishing Co., Ltd., 416-17 Caxton House, Westminster for 5s, postage extra.

This book is an elementary treatise on the subject. The introduction deals with the development of the science of aeronautics, safety of aerial travel and the remarkable growth of aviation. The first chapter deals with lighter-than-air craft; the second with heavier-than-air craft; the third with airplane construction; the fourth with engine types and propellers and the last with airplane control and flying instruments. The book contains discussions on balloons of the captive and dirigible types, airplanes of various types including the helicopter and construction and operation of the different kinds. Illustrations, dimensions and other data of many of the famous flying machines also are included.

William Robbins has been appointed district manager in charge of the Chicago office of the Chisholm-Moore Hoist Corp., Tonawanda, N. Y.

WHAT OTHERS ARE THINKING

Abstracts Selected from the World's Foundry Literature

Gives Pouring Temperatures

Casting Gun Metal, by H. C. Dews, *Metal Industry*, London, March 8, 1928.

This is the second part of a paper presented by the author at a meeting of the London branch of the Institute of British Foundrymen in which he discusses the effect of casting temperature on gun metal. According to results obtained only a narrow temperature range is available for good quality castings, and this is around 1160 degrees Cent. (2120 degrees Fahr.). In general at a temperature of 1300 degrees Cent. (2372 degrees Fahr.) dense clouds of zinc fumes will obscure the surface of the metal. As the temperature falls to about 1200 degrees Cent. (2192 degrees Fahr.), the surface becomes visible through the fumes and about 1140 degrees Cent. (2084 degrees Fahr.) the metal suddenly ceases to evolve zinc unless it is stirred. From this temperature downward the color becomes duller. At about 1060 degrees Cent. (1940 degrees Fahr.) the metal sticks to a skimmer plunged into the liquid and below 1000 degrees Cent. (1832 degrees Fahr.) most bronzes are too thick to pour into a mold.

It is common to find when a faulty casting is broken open, that the fracture shows patches of red, brown, green and similar multi-colored patches. The cause of this has been attributed to oxidation, stewing and improper mixing, but in reality it is due to faulty casting temperature. Large coarse crystals indicate that the metal has been poured too hot. When the fracture is *cokey* and has no definite crystallization, it is a sign that the casting temperature has been too low. The proper fracture produced by the best casting temperature will be just sufficiently crystalline to be recognizable as such; it will show a narrow blue skin where the metal has been in contact with the mold and will be entirely free from red or brown patches.

Add Secondary Air

Cupolas With Complete Combustion, by M. Spiece. *Bulletin de l'Association Technique de Fonderie de Belgique*, Brussels, April, 1929.

The author endeavors to show how combustion can be inproved by the injection of secondary cold air in the zone where the burden is at red heat. After showing that the utilization of heat lost in the gases escaping from the cupola is not practicable, the author shows how the introduction of secondary air reduces coke consumption by 3 per cent. The quantity of air to be introduced is calculated easily. Its pressure is shown to be from 10 to 20 millimeters in excess of the pressure existing at the point where the air is injected. The region in which the secondary air should be introduced corresponds to the zone starting where the metal begins to melt, and ending where the gas becomes inflammable, that is, in a range of temperature from 1200 to 700 degrees Cent. The number of air inlets is calculated to be equal to the length of the inside circumference of the cupola, divided by the length of the flames. For a 1-ton cupola, 8 inlets are necessary, 9 for a 2-ton cupola, 10 for 3-ton, 12 for 4 to 5-ton, 15 or 16 for a cupola of from 6 to 7-ton capacity. Finally, it is shown that the best position for the air inlets is along a helicoidal line.

From a practical standpoint, it is shown that a decrease of CO, together with an increase of CO_2, is favored by a reduction of coke reactivity. It is recommended to use a compact and hard coke. It also is advisable to put a proportion of heavy scrap in the burden, the cooling effect of which retards the decomposition of CO_2. The author emphasizes the fact that a rational operation of the cupola is necessary above all. If it is desired not to exceed a consumption of coke of from 8 to 10 per cent, a well-conducted ordinary cupola should be chosen. To insure further economy, a cupola with extra inlets for secondary air, as described, should be used.

Cupola Slags Are Important

Cupola Slags, by Matthes Miklau, *Die Giesserei*, Dusseldorf, Germany, June 7, 1929.

Cupola slags are earth silicate slags containing earthen bases and silicic acid. Their chemical investigation generally is limited to the CaO, SiO_2, Al_2O_3, MgO, MnO, FeO, Fe_2O_3 and S content. Cupola slag is formed by the addition of limestone which combines with the ash of the coke, sand on the pig iron, gates, etc., and a part of the cupola lining. Good limestone should not have over 5 per cent impurities in the form of silica and clay substance. The quantity of stone added is 25 to 50 per cent of the coke splits or 3 to 5 per cent of the iron charges. Addition of fluorspar is not necessary if pure, high CaO content stone is used. Fluorspar is expensive and attacks the cupola lining strongly. Melting temperature of the slag must be as low as possible so that too much fuel is not used. A calcium silicate rich in silicic acid melts easiest with a silicon ratio of 1 to 3.1. This will contain 38.3 per cent lime and has a melting point of 1400 degrees Cent. With a greater or lesser silicon ratio it is harder to melt. A favorable composition for slag is given as 17 to 20 per cent alumina, 22 to 32 per cent lime and 50 to 57 per cent silica. An increase in slag quantity results in a most favorable effect for the iron is protected best from oxidation. FeO and MnO lower the melting temperature, and MgO makes slag viscous. If the silicon ratio is about 1 to 1.3 titanic acid does not have much effect. However, if the slag is basic (silicon ratio below 1 to 1) the melting point of the slag is raised. Lime as a base protects the manganese at the beginning from oxidation. With decreasing lime and increasing CO_2 in the gases more manganese is burnt. A good desulphurization takes place when the slag is as basic as possible and fluid. Increasing lime and iron oxide content promote sulphur removal. A slag with 40 per cent silica will take up twice as much sulphur as a slag containing 55 per cent silica. The author could find no difference in sulphur removal, slag or iron whether the slag removal was periodic or continuous. Proper attention to slags will decrease defective castings.

Chromium Additions Resist Heat

The Influence of Chromium in Cast Iron, by J. W. Donaldson, *Foundry Trade Journal*, London, June 27, 1929.

With the exception of Hurst's work little has been done on the heat resisting properties of chromium cast irons, and to obtain some data the author carried on an investigation using a cast iron of the following composition: Carbon, 3.20 per cent; silicon, 1.5 per cent; phosphorus, 0.7 per cent, and manganese, 1.0 per cent. Chromium was added to this base to obtain irons containing 0.20, 0.39, 0.66, 0.78 and 0.90 per cent chromium. The chromium was added as 65 per cent ferrochromium in the ladle and the resulting iron remelted in crucibles to insure thorough mixing. All irons were cast into bars 1⅛ inches in diameter and 16 inches long in dry sand molds. The author's conclusions follow: Chromium added to gray cast iron in quantities up to 0.90 per cent increases the stability of the combined carbon at temperatures up to 550 degrees Cent. (1022 degrees Fahr.) This increase in stability is probably due to the presence of chromium carbide in the cementite of the pearlite, and is reflected in the increased strength both at ordinary and elevated temperatures, and in the brinell hardness. Better heat resisting irons are obtained, but there is difficulty in machining irons with over 0.4 per cent chromium. The influence of chromium on volume changes at temperatures below the critical range is erratic, but the general effect is to produce a contraction. The nature of this contraction is difficult to explain or define. With chromium up to 0.4 per cent the thermal conductivity is increased about 8 per cent. Small additions of chromium slightly reduce the corrosion of gray cast iron. The effect is most noticeable with sea water and to a lesser extent with strong acids. With weak acid, tap water and ammonium chloride little advantage is gained.

The Shakeout

DAN M. AVEY, *Editor*
FRANK G. STEINEBACH, *Managing Editor*
PAT DWYER, *Engineering Editor*
EDWIN BREMER, *Metallurgical Editor*
CHARLES VICKERS, *Nonferrous Editor*
NORMAN F. HINDLE, *Assistant Editor*

¶ Paying the Customer's Loss

A BRITISH marine architect recently was recounting his experience as an expert witness in a case against a foundry making ship castings. The failure of an important steel casting on a ship several months in service, resulted in docking for repairs. The ship's owners sued the foundry for the cost of the casting, the expenses of preparing it and installing it and also a heavy damage for loss due to delay while the ship was out of service. A British court awarded full damages against the foundry and used as the basis for the judgment a letter in which the foundry managing director promised delivery of a *sound* casting.

WITHOUT the full facts, no reasonable person could go behind the verdict, although some measure of responsibility would seem to rest upon the shipbuilders and the owners for not having assured themselves of the soundness as well as the adequate design of the part. However, the fact remains that a letter was held to be a binding contract. Progressive foundrymen and particularly those identified with live trade associations are awake to the need for clear and explicit contract forms for the sale of castings. These should set forth exactly the responsibility of the foundry and the customer. Furthermore, no competent foundryman should promise or assume by word or letter more than he can be expected to fulfill. No foundry would intentionally produce unsound work, but why promise beyond ability to perform and why assume unknown responsibility to secure a casting order?

¶ Worthwhile Influence

MOST of us devote too much attention to our own immediate problems and allow the broader aspects of public affairs to be juggled by professional politicians. However, the old regime is changing, and it is comforting to note that at last, the engineering profession through its organization, the American Engineering council is making its voice heard by constructive effort in influencing legislative and adminstrative action. The council's work from the study of waste in 1921 to the traffic survey in 1929, has been highly informative to the nation at large and creditable to the engineering profession. By such work, engineering is assuming a new importance and dignity in public affairs.

THIS is as it should be, each of us should take more than a cursory interest in that greatest business of all, the spending of public funds. Since everyone contributes through some form of taxation, he should see that it is expended for value received, and not thrown away. While the opinion of one individual may not exert much influence, the value of organized, constructive opinion is inestimable. This does not mean that an organization has to indulge in political skullduggery to make its influence felt. Unified opinion expressed after careful consideration of public projects may prevent unnecessary taxation for needless improvements, and place a check upon lax-fingered holders of the public purse strings.

¶ Passing the Buck

ONE of the great indoor sports seems to be what is known as *passing the buck*. This game is played by people in all walks of life. The foundryman is not immune from it. In fact, buck passing is encountered as much in the foundry as in any other industry. When something goes wrong in the foundry and the manager attempts to find the reason, it generally is a case that the metal is at fault as far as the molding department is concerned and the molding practice should be revised as far as the melting department is concerned, and so it goes. Each deparment blames the other and at the same time is positive that nothing could be wrong in its own province.

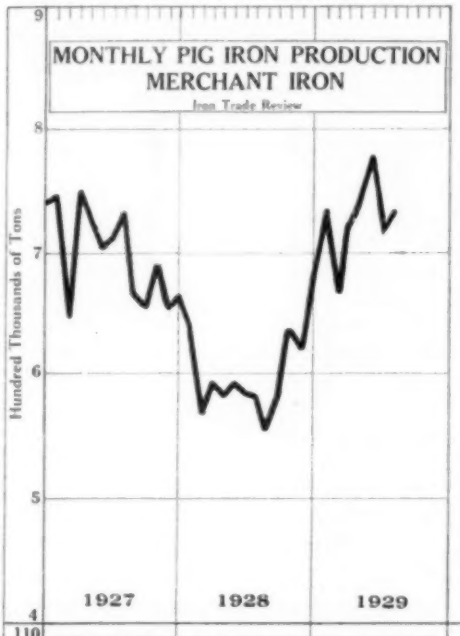
IT OFTEN is difficult to find the cause of defects in castings for that reason. Passing the buck is a costly game, for while all the discussion is going on each department, trying to keep its record clean, fails to co-operate in locating the true cause of the defect. Meanwhile, the company suffers because of lack of co-operation. It takes so little sacrifice of pride to admit there is a possibility of being wrong and working in harmony with others. The road will be much easier through co-operation, not only for heads of departments and the management, but for the men.

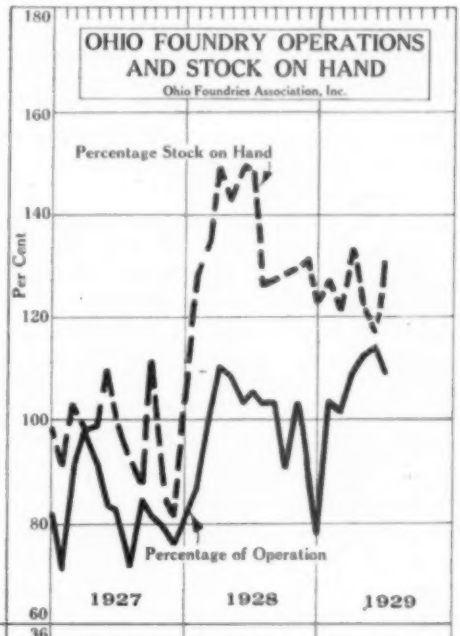
Trade Trends in Tabloid

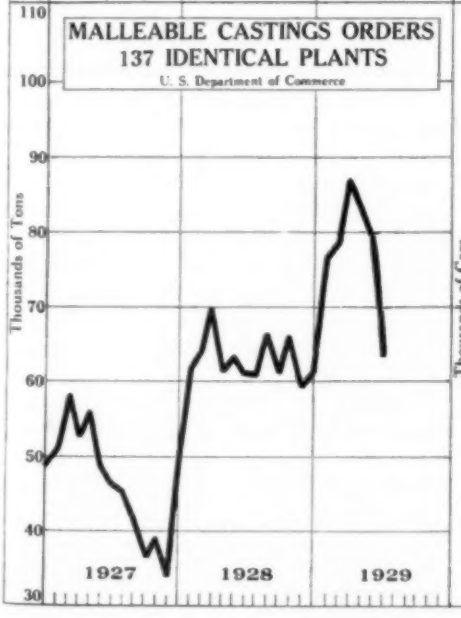
WHILE foundry operations declined slightly in July, production of castings is at a higher rate than during the summer period in any recent year. Automobile production has dropped as numerous manufacturers prepare to introduce new models. It is thought by men in the industry that production in August will be slightly under the total for July, but that September will develop a sharp comeback. While railway car buying was slow during the first part of the month, a large number of car orders are pending. An upward movement in prices for farm products has created a more favorable outlook for agriculture. This condition may be reflected in increased equipment buying in the near future. Pig iron, with an average daily production of 122,016 tons, showed a slight decrease over the rate for June, according to *Iron Trade Review*. However, the rate was only 3 per cent lower than that made during May, 1929, the best month on record. The long month permitted the production of 3,782,511 tons as compared with 3,715,104 tons in June. Merchant iron produced in July totaled 741,622 tons. Average nonferrous prices for July, according to New York quotations in *Daily Metal Trade* follow: Casting copper, 17.385c; electrolytic copper, 18.000c; Straits tin, 46.32c; lead, 6.805c; antimony, 8.422c; aluminum, 23.90c. Zinc prices averaged 6.754c at East St. Louis, Ill.

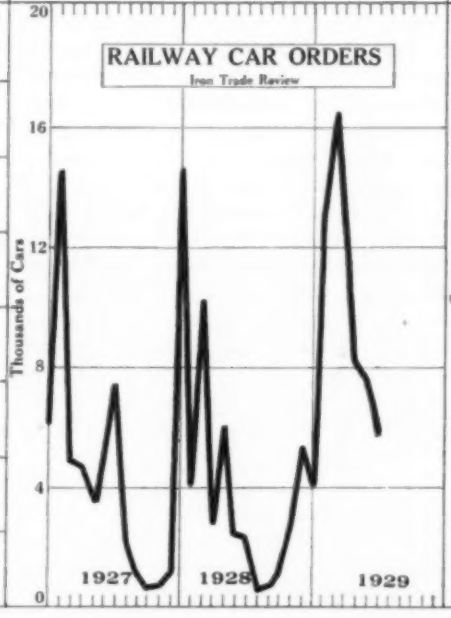
RAW MATERIAL PRICES
Aug. 6, 1929

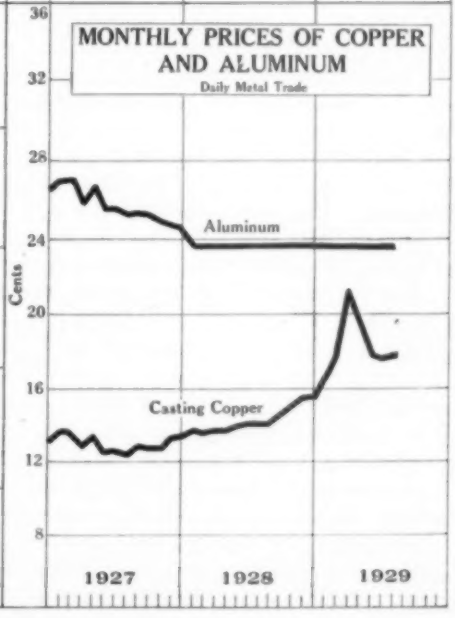
Iron	
No. 2 foundry, Valley	$18.50
No. 2 southern, Birmingham	14.00 to 14.50
No. 2 foundry, Chicago	20.00
No. 2 foundry, Philadelphia	21.76 to 22.26
No. 2 foundry, Buffalo	19.50
Basic, Valley	18.50
Basic, Buffalo	18.50
Malleable, Chicago	20.00
Malleable, Buffalo	20.00
Coke	
Connellsville foundry coke	$3.75 to 4.85
Wise county foundry coke	4.25 to 5.00
Scrap	
Heavy melting steel, Valley	$18.50 to 19.00
Heavy melting steel, Pitts	18.50 to 19.00
Heavy melting steel, Chicago	14.75 to 15.25
Stove plate, Buffalo	12.75 to 13.25
Stove plate, Chicago	11.50 to 12.00
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.50 to 15.00
No. 1 cast, Philadelphia	16.00 to 17.00
No. 1 cast, Pittsburgh	15.00 to 16.00
No. 1 cast, Birmingham	14.00 to 15.50
Car wheels, iron, Pittsburgh	16.50 to 17.00
Car wheels, iron, Chicago	14.00 to 14.50
Railroad malleable, Chicago	17.00 to 17.50
Agricultural mal., Chicago	15.50 to 16.00
Malleable, Buffalo	18.00 to 18.50
Nonferrous Metals	**Cents per pound**
Casting, copper, refinery	17.50
Electro, copper, producers	18.00
Straits tin	47.12½
Lead, New York	6.75
Antimony, New York	8.62½
Nickel, electro	35.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	17.00 to 17.50
Zinc, East St. Louis, Ill.	6.80











Personal

C. R. Phoebus has become business manager of the Warsaw Foundry Co., North Detroit street, Warsaw, Ind.

C. W. Miller has resigned as secretary and treasurer of the Ohio Malleable Iron Co., Columbus, O. He also resigned as treasurer of the Jeffrey Mfg. Co., Columbus.

H. S. Rowden has been made chief of the division of metallurgy, bureau of standards, Washington, succeeding H. W. Gillett, resigned. Mr. Rowden has been in charge of optical metallurgy of the bureau.

A. H. Corey, for five years factory engineer of the Piston Ring Co., Muskegon, Mich., recently resigned to become general manager of the piston ring department of the Aluminum Industries Corp., St. Cloud, Minn.

Herbert Templin formerly in charge of foundries in Passaic and Newark, N. J. has been appointed foundry superintendent of the Wm. T. Barker Foundry, Bridgeton, N. J., recently purchased by the Farracute Machine Co., Bridgeton, N. J.

Harry G. Hart has sold his interest in the Salem Brass & Iron Mfg. Co., Bridgeton, N. J., to his former partners, Joseph Powers and Thomas H. Powers, and the company has been reorganized with Joseph Powers as president and Thomas H. Powers as secretary and treasurer.

Charles E. Satler, secretary of the United Engineering & Foundry Co., Pittsburgh, and an employe of that company for 44 years, has resigned. George H. Friesel, treasurer, has been elected secretary in addition to his regular duties. J. H. Hillman Jr. has been elected a director of United Engineering to fill a vacancy.

C. W. Nixon has been made manager of operations of the southern plants of the Central Foundry Co., with headquarters at Bessemer, Ala. The company maintains foundries at Bessemer, Holt and Anniston, Ala., Vincennes, Ind., and Baltimore, Md. Mr. Nixon formerly was assistant to the general manager of the plant at Holt, Ala.

Increases Membership

The Gray Iron institute, Cleveland, recently elected the following foundries to membership: Barnett Foundry & Machine Co., Irvington, N. J.; Kelly Foundry Co., Pittsburgh, Pa.; James McKinney & Son, Albany, N. Y.; Brooklyn Foundry Co., Astoria, N. Y.; Old Colony Foundry Co., East Bridgewater, Mass.; Gibby Foundry Co., East Boston, Mass.; L. W. Pond Machine & Foundry Co., Worcester, Mass.; and Central Foundry Co., Joplin, Mo.

Announces Program for Dusseldorf Meeting

The program for the autumn meeting of the British institute of metals, to be held in Dusseldorf, Germany, September 9 to 12, recently has been announced. Among the papers to be presented are the following: "Aluminum and Its Alloys," by Dr. A. G. C. Gwyer; "Idiomorphic Crystals of Cuprous Oxide in Copper," by C. Blazey; "Pinholes in Aluminum Alloy Castings," by N. F. Budgen; "A Dilatometric Study of Some Univariant Two-Phase Reactions," by P. Chevenard, A. M. Portevin, and X. F. Wache; "The Relative Corrodibilities of Ferrous and Nonferrous Metals and Alloys. Part II—The Result of Seven Years' Exposure to Air at Birmingham," by J. Newton Friend; "An Improved Differential Dilatometer," by M. Haas and D. Uno; "The Creep of 80:20 Nickel-Chromium Alloy at High Temperatures," by A. Glynne Lobley; "Methods of Research in Metallography," by G. Masing; "Reduction of Shrinkage Cavities and Vacuum Melting," by W. J. P. Rohn; "Some Methods of Research in Physical Metallurgy," by W. Rosenhain; "New Methods for Melting Nonferrous Metals in the Electric Furnace," by M. Tama.

A number of social events will take place in conjunction with the meeting.

Purchases Foundry

Pittsburgh Steel Foundry Corp., Glassport, Pa., has acquired the Sharon Foundry Co., Sharon, Pa., for a cash consideration. The Sharon Foundry Co., capitalized at $500,000, operates two, 25-ton, acid, open-hearth furnaces and engages in the production of miscellaneous steel castings for rolling mills and machinery builders, including annealing boxes and bottoms. L. A. Way is president of the Sharon company. Pittsburgh Steel Foundry Corp. operates four open-hearth furnaces and has a monthly capacity of 2500 tons, producing steel castings and rolling mill machinery. Stewart Johnston is president of the Pittsburgh company.

Western Iron Stores Co., Milwaukee, has been appointed sole agent in the state of Wisconsin for the products of N. A. Strand & Co., 5001-07 North Lincoln street, Chicago.

Windsor Brass Foundry Builds New Shop

J. B. Ripley Brass Foundry Inc., Windsor, Vt., recently moved into its new plant north of Coolidge Court on a plot of land 4¼ acres in extent and with a frontage of 900 feet on the railroad track. The new foundry 40 x 140 feet, fireproof, constructed of concrete, steel and glass is modern throughout and is equipped to the fullest extent with mechanical aids. Present capacity of the plant is 4 tons of finished castings per day. Provision has been made on the north side of the building for future addition.

Metal is melted in a battery of oil fired furnaces that are supplied with fuel from three 1000-gallon tanks located under ground on the east side of the building. Air for the molding machines and cleaning room is furnished by a 40-horsepower motor driven compressor. Cores are dried in an oil fired drawer type oven. Grounds surrounding the building present an attractive appearance.

Study Bearing Bronzes

Bronzes in the copper corner of the copper-tin-lead system are classified according to the character of the service for which they seemed to be adapted best, based upon a study of the wearing properties, hardness, structure, notch-toughness and resistance to deformations at temperatures between 70 and 600 degrees Fahr., in Research Paper No. 68 published by the bureau of standards. The title of the paper is "Bearing Bronzes with and without Zinc," by H. J. French and E. M. Staples. The price of the bulletin is 15 cents.

Obituary

M. Brooke Meanley, 49, of the Jones Holloware Co., Baltimore, well known foundryman, died in that city recently of pneumonia.

Louis Wakeman Penfield, formerly head of the Hadfield-Penfield Steel Co., with plants at Bucyrus and Willoughby, O., and well known during the world war for his part in the manufacture of munitions, died at his home in Willoughby, July 29.

Charles E. Pack, for the past six years eastern sales representative for the Lava Crucible Co. of Pittsburgh, Pittsburgh, died at his home in Bridgeport, Conn., July 13, at an age of 54 years. Mr. Peck was known well to the brass foundrymen in the eastern part of the country.

Produces Steel Castings

(*Concluded from Page* 710)

remaining time the heat would be in the furnace. As the boil was uniform, after the reboil from the silicon, we could expect a rapid transfer of heat to the metal from the flame which was maintained full enough to reach across the bath.

Being sure of proper temperature conditions, and the heat being satisfactory in every other respect, a ladle was ordered and preparations were made for tapping. The first move was to add another 573 pounds of spiegel so that the carbon would not change while tapping, and to increase the residual manganese. It was thought the manganese would be increased 10 points from the last round of spiegel. By it having increased 12 points we judged the bath to have been well deoxidized, this was further proven by the fact that the carbon remained constant for 12 minutes—this being the time from the go-ahead test until the metal was in the ladle.

Time consumed in working the heat was 1 hour. The metal bath was increased in weight by less than 1800 pounds. Yet the condition at melting was fully as bad as the case wherein 10,000 pounds of pig iron was added, also the condition of the metal was normal which was not the case in the former instance at tapping. In summing up the procedure in each case the following observations are made in dealing with over-oxidation:

Adding 10,000 pounds of straight pig iron gave the elements needed as follows: Carbon 350 pounds (perhaps a little more), silicon 100 pounds, and manganese 150 pounds (probably less). The time required to add the pig was 3 hours or more, for a good many rounds had to be added when only 9 small pieces were put in at a time. This fact is mentioned to call attention to the fact that the doors had to be raised many times during the operation, admitting a tremendous volume of air which struck the bath directly both cooling it and forming iron oxide with any metal which might be exposed.

Adding 1000 pounds of spiegel supplied: Manganese 200 pounds, silicon 10 pounds, and carbon 60 pounds. Adding 300 pounds of high silicon pig supplied: Silicon 36 pounds, carbon 12 pounds, and manganese 3 pounds (more or less). In all these additions to the molten bath supplied: Manganese 203 pounds, silicon 46 pounds, and carbon 72 pounds.

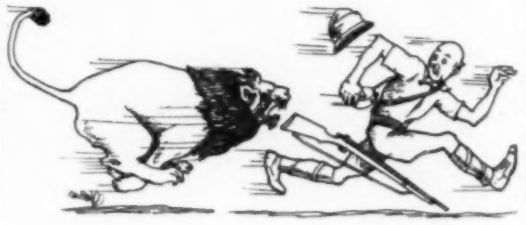
Since in both cases the metal was at a temperature sufficiently high to make the carbon attack iron oxide with as much avidity as either the manganese or the silicon it is apparent that there was almost twice as much reducing element used in the former case as in the latter. Yet at no time was the former heat even partially deoxidized, while the latter was pretty well deoxidized as was evident from the fact that the carbon did not lose a point during the operation, that is, after steps had been taken to clear up the heat when it was discovered that it was low in carbon.

The lesson to be learned from this treatment of a heat in the best way yet developed may be summarized in the following manner:

Analyze the condition to discover the needs without loss of time. Take immediate steps to deoxidize the bath, and stop further oxidation of iron. Do not thin the slag out too much—the manganese oxide and silica formed by the oxidation of these elements will confer fluidity on the slag. Do not use enough high silicon pig at one time to kill the action in the bath. If the bath is charged heavily with silicon a violent reboil will occur resulting in a considerable loss of carbon. This may happen just when about to tap after calculations for recarburizer in the ladle have been made. Keep the doors closed tightly except when adding material. Keep a full and voluminous flame on the furnace throughout.

To put new life in a heat after it has become over-oxidized without adding largely to the cost of its production is not an easy matter. The average steel foundry must have metal which is not only lively, but it must remain so for from 40 minutes to 1½ hours depending on the size of the molds that must be poured.

Faked Foundry Facts



Setting the Gait

Readers Comment

Note—Material appearing under this head does not necessarily reflect the opinion of THE FOUNDRY or of its editors.

TO THE EDITORS:

Referring to a question concerning difficulty with wild steel from an electric furnace, described under the title "Metal Is Wild" on page 615 of the July issue of THE FOUNDRY. I quite agree with the answer given in your columns but do not think it went far enough.

The question outlines the change from 75 kilovolt amperes to 300 kilovolt amperes and gives the voltage drop as from 130 to 100 volts under load. It is likely that with the old transformers it was not necessary to cut the load to any great extent after the metal was ready for pouring. With the new transformers it is obvious that the load must be decreased a great deal after the metal has reached temperature, to avoid burning the furnace. With the load reduced the voltage will rise considerably above 100 at the furnace and there will be a much longer arc. The remedy would be to control the voltage at the furnace so that it would run between 90 and 100 volts during the refining and pouring period. From the outlined analysis I believe the silicon is too low to effectively kill the metal, especially if pouring in green sand molds. A silicon content of 0.25 per cent may, under good conditions, give solid metal; but a drop of several points will result in cheese, indicating too close a margin for safety. A silicon content of 0.30 to 0.35 per cent would give the necessary margin without affecting the physical properties of the casting. It has been my observation that electric steel, carefully deoxidized, contains as much or more dissolved gases than good quality open hearth casting steel, which requires 0.30 to 0.35 per cent silicon.

If, however, satisfactory results have been gained in the past with 0.25 per cent silicon, and there has been no change in molding or pouring practice, I would lean to the belief that the trouble lies in too high a refining voltage perhaps coupled with excessive temperature made possible by the increased power.

Columbus, O. A. MELTER

Magnetic Mfg. Co., Milwaukee, has appointed Wells Fargo & Co., S. A., Mexico, as their representative in the Republic of Mexico.

GRINDER IS BUILT ON THE ROTARY PRINCIPLE

Portable Grinder Has Four Moving Parts

Buckeye Portable Tool Co., Dayton, O., has introduced a new type portable grinder which has only four moving parts. It is lighter in weight and smaller in diameter than previous models of the company. It is built on the rotary principle. Air is supplied to the machine in such a way as to minimize vibration. The grinder is equipped with a new type speed governor designed to maintain a speed within 100 revolutions per minute of the free speed of the tool. The governor, if it should break, will stop the machine and will not allow the grinding wheel to race. The parts of the machine are interchangeable with others of the same type. This new type grinder may be obtained with speeds regulated either for high speed or vitrified wheels and for wheels with diameters of either 6 inches or 8 inches.

Compressor Is Equipped With Roller Bearings

Worthington Pump & Machinery Corp., Harrison, N. J., has introduced a new line of compressors of the single, horizontal, straight line type equipped with roller bearings on the main crank shaft journals. Capacities range from 100 to 300 cubic feet per minute.

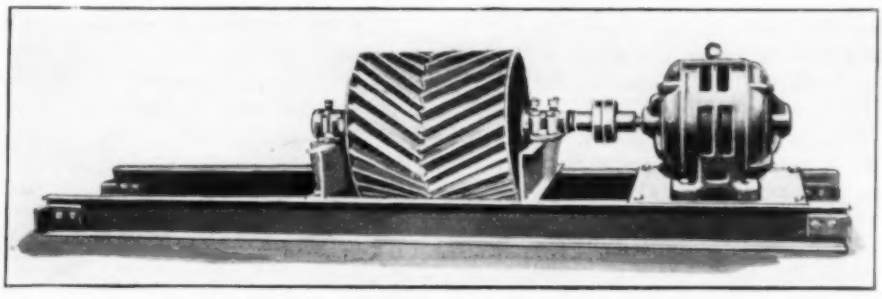
Oil rings, which deflect the surplus oil and return it to the crankcase, are mounted on the shaft beyond the roller bearings. A feature of the machine is the crankcase enclosure which is oil tight. Valves of the feather type are standard equipment on the new compressors. They are light strips of steel, approximately 1/32-inch thick, which flex when they are opened against a curved guard.

The machines may be regulated by an automatic starter and pressure switch mounted on the motor. By starting and stopping the motor, the air pressure may be controlled between definite limits. An alternative method is to have a pressure regulator attached to the compressor inlet valves holding them open to maintain constant pressure.

The compressors may be obtained with ball bearing idlers for short belt drive; with rope drives, using V-type ropes or a synchronous motor may be mounted directly on the compressor crank shaft.

Makes Sand Aerator

Beardsley & Piper Co., 2541 North Keeler avenue, Chicago, has introduced a machine for aerating sand as it comes from the discharge belt to the hopper or storage bin. That machine, shown in the accompanying illustration, consists of a motor driven drum on the face of which are staggered blades extending from the outer edge to the center. The drum resembles a herringbone gear. The unit is made for mounting under the discharge belt in the storage tank. When it is in operation, it whirls the incoming sand to all parts of the tank. This action is said to aerate and cool the sand and break up any lumps that may have gathered on the conveyor. This piece of apparatus is made to suit conditions and may be installed on either new or old installations of sand conditioning equipment.



THE DRUM RESEMBLES A HERRINGBONE GEAR, THE BLADES BEING STAGGERED AND EXTENDING FROM THE OUTER EDGE TO THE CENTER

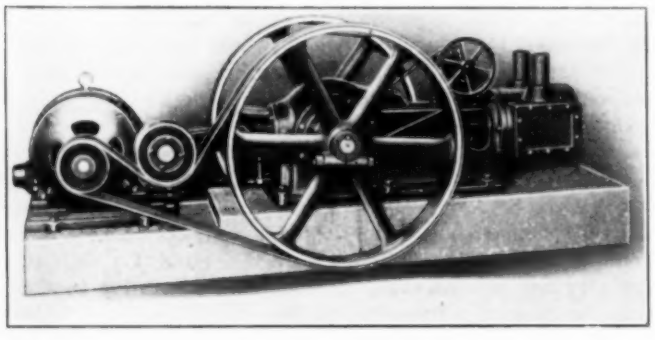
Acquires Control of Three Foundries

Blaw-Knox Co., Blawnox, Pa., has obtained control of the Union Steel Casting Co. and the Lewis Foundry & Machine Co., Pittsburgh, and the National Alloy Steel Co., Blawnox, Pa., contingent upon the deposit of sufficient stock of each company to give the Blaw-Knox Co. control. Each organization, however, will retain its corporate identity. The basis for the exchange of stock in the respective companies is not announced except in the case of the Union Steel Casting Co., stock of which will be exchanged in the ratio of ⅞ share of Blaw-Knox for one share of Union Steel Casting. Union Steel Casting Co. has an annual capacity of 36,000 net tons and owns the entire capital stock of the Pittsburgh Rolls Corp., Pittsburgh. Lewis Foundry & Machine Co. engages in the production of rolls and rolling mill machinery. Albert C. Lehman is president of the Blaw-Knox Co. and chairman of the National Alloy Steel Co.

Reduces Spotting Out

Recently the bureau of standards published Research Paper No. 72 on "The Spotting of Plated or Finished Metals," by W. P. Barrows. The author concludes that the amount of stain spotting may be reduced by using a less porous base metal; by dry burnishing, and by eliminating alkaline cleaning or plating solutions. Stain spotting also may be reduced by allowing the articles to spot out for 24 hours or more prior to the final finishing and lacquering. The best general remedy is to use satisfactory lacquer films. The price of the bulletin is 10 cents.

Engineering experiment station. University of Illinois, Urbana, Ill., has published Bulletin No. 193 on "An X-ray Study of Firebrick." The price of the bulletin is 15 cents.



Capacities of the Compressor Range from 100 to 300 Cubic Feet per Minute

Drum Controller Has New Features

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has introduced a new line of reversing drum controllers designed for both direct and alternating current use. They are designed for many uses in the operation of cranes, hoists, bending rolls, railway turntables, etc.

The drum cylinder consists of rolled brass supporting disks assembled on an insulated, steel shaft between brass and insulating collars. The contact segments are bolted to the supporting disks in a way that eliminates burning of the bolt heads. Segments are reversible and burned ends may be trimmed down to form shorter segments.

The fingers are of the compensating, self-aligning type. An adjustment is provided to compensate for finger wear. Localized heating of the joints is prevented by copper shunts direct from the terminals to the finger tips.

Easy operation of the controller is provided by a flexible, roller bearing in the top and a ball, thrust bearing in the base. Several types of operating heads may be used with this controller to suit the requirements of various installations.

Equips Grinding Machine With Ball Bearings

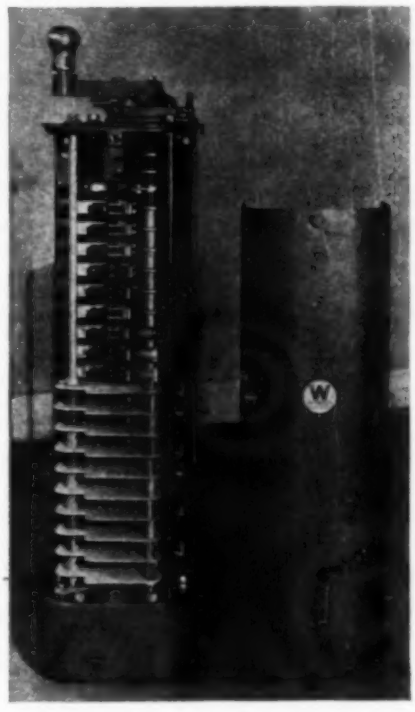
Hill-Curtis Co., Kalamazoo, Mich., has introduced a new type, 6-inch and 8-inch electric driven grinding machine. The grinder is made in both the bench and pedestal types and is manufactured for any standard motor specifications. Oversize ball bearings are mounted in the end head near the wheels and are enclosed completely. The motor is of the totally enclosed type.

Single-phase, alternating current machines are equipped with the commutating type repulsion-induction motor which has no dragging centrifugal switch. Low voltage has no objectionable effect on that type single-phase machine and the starting current is low. Motors on all machines are guaranteed to develop name plate horsepower rating and are built to withstand a momentary overload of 100 per cent in excess of the rated capacity.

The machine is equipped with a quick make and break type switch. Wheel guards and tool rests are adjustable to the wear of the wheels and may be removed when the work does not permit their use.

MACHINE IS MADE IN BOTH THE PEDESTAL AND BENCH TYPES

Machine Uses Vitrified Wheels



FINGERS ARE OF THE COMPENSATING, SELF-ALIGNING TYPE

Designs Die Grinder

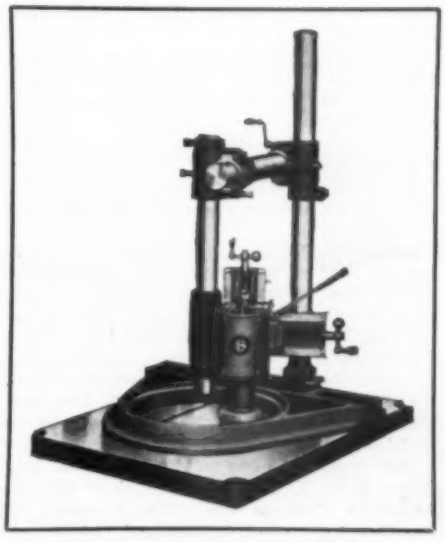
Rotor Air Tool Co., Cleveland, has introduced a new die grinder for 1½-inch, vitrified wheels, 2½-inch, high speed wheels and ½-inch pencils. The tool is designed for use on dies, metal patterns, for finishing brass, bronze and aluminum castings and for scroll work on ornamental pieces. The grinder, shown in the accompanying illustration, develops about ½ horsepower at 13,000 revolutions per minute. Standard equipment includes an arbor for wheels ⅜-inch in width and having a ⅜-inch hole. On special orders, arbors are supplied for ¼-inch and ½-inch holes. A large line of accessory equipment is offered including a collet designed to hold a ½-inch shank for mounting small wheels. The same collet may be used to hold different mounted points.

Designed For Flat Work

United States Electrical Tool Co., Cincinnati, recently introduced an electric grinder especially designed for grinding and surfacing flat work. The machine is capable of handling work for 24 inches to 30 inches in circumference. A manhole is shown mounted on the grinder in the illustration.

The machine is driven by a 2-horsepower motor equipped with ball bearings. The lower bearing is of the combination radial and thrust type. The base is 36 x 48 inches. "T" slots in the surface of the base aid in clamping the work. The upright column is 48 inches high and is equipped with a stop collar and a double collar of the pinch bind type. The cross arm is a 3½-inch, steel tube, 36 inches long. The double collar is fixed. The arm holding the grinder is 3-inch solid cold rolled steel. The grinder mounting collar is equipped with ball bearings top and bottom. The mounting has two adjustments, vertical 6 inches and horizontal 8 inches.

S. H. Sutton, formerly of the Chicago Gas, Light & Coke Co., has been appointed Chicago district manager of the William H. Nicholls Co. Inc., Richmond Hill, N. Y.



GRINDING MANHOLE COVERS

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Comador Furnace & Foundry Co., Niantic, Ill., has been moved to Vandalia, Ill.

Auburn Foundry, Auburn, Ind., suffered slight damage by fire recently.

Canon City Foundry & Machine Co., Canon City, Colo., reports business good.

J. W. Pohlman Foundry Co., 205 Baitz avenue, Buffalo, has started construction of a 1-story plant addition, 30 x 84 feet.

West Michigan Steel Foundry Co., Muskegon, Mich., has been issued a permit for construction of an addition costing about $20,000.

Photogenic Machine Co., 512 Andrews avenue, Youngstown, O., has purchased a plant at 21 Olive street, where it plans to build a foundry.

Akron Foundry Co., Akron, Ind., has completed its new building and will start operations soon.

Morgan Brass Foundry, Lincoln avenue, Providence, R. I., which recently was destroyed by fire, has plans for a new plant. New equipment will be needed.

Hart Mfg. Co., 1600 North Western Parkway boulevard, Louisville, Ky., manufacturer of furnaces, castings, etc., plans rebuilding part of the plant recently destroyed by fire.

Model Brass Foundry Co., 2309 Hickory street, Dallas, Tex., has plans for extensions and improvements to its foundry, which will cost about $25,000.

Fairhaven Iron Foundry, 2 Water street, Fairhaven, Mass., has awarded a contract for rebuilding one and 2-story plant, 50 x 100 feet. (Noted June 15.)

Weldon Foundry Co., Wayne, Mich., has been incorporated with 5000 shares of no par stock to operate a general iron and metal foundry, by John Enot.

Wabash Foundry Co., Wabash, Ind., has started construction of an addition to its foundry which will provide about 7300 square feet of floor space.

C. N. Gray Mfg. Co., 358 Central avenue, East Orange, N. J., manufacturer of die castings, contemplates a three-story addition to cost in the neighborhood of $70,000.

Liberty Foundry Co., 368 State street, Wauwatosa, Wis., will place a contract for erection of a brick and steel foundry addition having a floor area of about 27,000 square feet.

Minneapolis Electric Steel Castings Co., 3800 Fifth street, northeast, Minneapolis, has completed an addition containing 12,000 square feet. (Noted July 1.)

Fulton Iron Works Co., St. Louis, has been awarded the contract to equip a sugar refinery to be built at Villa Juarez, Tamaulipas, Mexico, near Tampico.

Mall-Gra Castings Co., Cambridge City, Ind., suffered an estimated loss of $30,000 by fire on July 18. The annealing and cleaning departments were practically destroyed. The plant now is being rebuilt.

Plantsville Foundry Inc., Plantsville, Conn., recently formed with capital of $50,000, will take over and operate the Walker-Stewart Foundry Corp., Plantsville, which recently filed a petition in bankruptcy. (Noted Aug. 1.)

Romeson Mfg. Co., Titusville, Pa., has been organized to take over the Titusville plant of the American Radiator Co., which has been closed for several years. The plant will be remodeled for early occupancy.

The corporate name of Smith Wheel Inc., Syracuse, N. Y., has been changed to Syracuse Perfection Castings Inc. The company has terminated the wheel division and now is concentrating all efforts in the casting division, which was established in 1882. The company manufactures malleable, gray iron, aluminum, brass, and bronze castings.

Reliance Steel Castings Co., Twenty-eighth and Smallman streets, Pittsburgh, is having plans prepared for an office and foundry addition. Lake & Davidson, Negley building, are architects.

Vanadium Metals Co., Boston Post road, Groton, Conn., has let the contract for a one-story foundry, 50 x 124 feet, to H. R. Douglas & Son, Barrows building, New London, Conn. The estimated cost of the new building and equipment is about $40,000.

Gogan Machine & Foundry Co., 1440 East Fifty-fifth street, Cleveland, has awarded construction contract for a plant addition, 40 x 72 feet, to the J. L. Hunting Construction Co., Guarantee Title building, Cleveland. Estimated cost about $70,000.

American Abrasive Metals Co., Newark, N. J., has completed a 50 x 75-foot addition to its foundry. This is for use as a finishing and shipping department and is being equipped with grinding wheels, electric torches, and similar equipment.

Modern Foundry & Pattern Works Inc., Oakland, Calif., has been purchased by the Aluminum Co. of America Inc., Pittsburgh. J. F. Russell and Peter Caird, president and vice president of the Modern Foundry Co., will continue in their present positions.

E. Gargani & Sons Inc., Brooklyn, N. Y., has been organized to operate a statuary bronze foundry. A long term lease has been secured on a foundry building at 100-108 Probost street in which extensive alterations and improvements have been made.

Glancy Malleable Iron Corp., Waukesha, Wis., which recently started work on a brick and steel foundry addition, 118 x 208 feet and a new shipping room 120 x 240 feet also will let contracts soon for a new cleaning room 85 x 200 feet.

Duraloy Co., Pittsburgh, has installed a 1½-ton electric furnace at a plant at New Cumberland, W. Va., for the production of chrome alloys. Additions also have been made to the plant machine shop to facilitate the output of machines for chrome alloy castings.

At Springfield, O., Ohio Steel Foundry Co., West Fourth street, Lima, O., awarded contract for a plant addition, 100 x 200 feet, to A. G. Samuelson Inc., Springfield. Overhead cranes, electric furnaces, grinding machinery, etc., will be installed. (Noted Aug. 1.)

American Radiator & Standard Sanitary Corp., 40 West Fortieth street, New York, has purchased the plant and business of Thos. Maddock's Sons Co., Trenton, N. J., and will operate the plant as a unit of the organization. An addition costing more than $300,000 is contemplated.

Traction Foundry & Machine Co., LaPorte, Ind., has been formed to conduct a foundry business and has taken over a foundry building which is being reconditioned and equipped to produce gray iron and semisteel castings. Operations probably will start the latter part of August.

New Trade Publications

STEEL CASTINGS—Lebanon Steel Foundry, Lebanon, Pa., has issued a 4-page folder on the use of its castings in mowing machinery.

MOLD HANDLING EQUIPMENT—Cleveland Tramrail division of the Cleveland Crane & Engineering Co., Wickliffe, O., in a recent folder illustrates the uses of its equipment in foundries.

HEATING DEVICES—The General Electric Co., Schenectady, N. Y., has issued a folder describing its industrial heating devices. The list includes soldering irons, glue pots, air drawing ovens, pot type furnaces for lead and cyanide hardening, and several types of heating units.

CONTROLLERS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is distributing a folder on its alternating current, reversing, drum controllers for wound rotor induction motors. The folder illustrates and describes the features of the machine and gives the application, operation and construction.

COMPRESSORS—Allen Air Appliance Co., 452 Lexington avenue, New York, has issued on 11-page booklet on centrifugal compressors and their uses. It describes by illustrations the construction and gives information on specifications, sizes and capacities. The bulletin also describes the vacuum cleaning equipment for institutional service.

SPEED REDUCERS—Palmer-Bee Co., Detroit, has issued a bulletin describing and illustrating the various types of speed reducers that it manufactures. Tables are included that give help in selecting reducer equipment. Working drawings and illustrations show both assembled and disassembled views of the reducers. Typical layouts and installations are presented.

FLOORS—Master Builders Co., 7016 Euclid avenue, Cleveland, has issued a series of folders on its surfacing material for floors. Illustrations show the effect of the hardener on cement floors. The booklets also contain illustrations from photographs of typical installations and comparisons of cement floors on which the surface hardeners were and were not used. Charts and other data show the effect of the materials.

REFRACTORIES — Corundite Refractories Inc., Massillon, O., recently has published a booklet explaining and illustrating the various types of refractories in which that company specializes. The booklet contains an illustrated list of the different standard shapes as adopted by the Refractories Manufacturers association it also contains tables which give useful information some of which relates to refractories.

BLOWERS—P. H. & F. M. Roots Co., Connersville, Ind., recently has issued a 16-page bulletin on its low pressure rotary positive type blowers for any capacity at pressures of 2½ pounds or less. The booklet is well illustrated with views of these types of blowers and typical installations. It also contains specifications and a working drawing of one type blower. General construction and advantages of the blowers are discussed.